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PROCEDURES MANUAL. DETROIT RIVER-LAKE ERIE PROJECT FIELD OPERATIONS SECTION. SECTION I. PROCEDURES FOR SAMPLING AND HYDRCLOGY. SECTION II. STORM WATER OVERFLOW AND DOMESTIC WASTE SURVEYS. BIOLOGICAL STUDIES

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National Center for Urban and Industrial Health
Chevy Chase, Maryland

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(6) Procedures Manual. Detroit River-Lake Erie Project
Field Operations Section.

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PROCEDURES MANUAL

FIELD OPERATIONS SECTION

DETROIT RIVER-LAKE ERIE PROJECT

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JULY 1962 - JUNE 1964

DETROIT RIVER-LAKE ERIE PROJECT

PROCEDURES FOR

SAMPLING AND HYDROLOGY

SECTION I

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METHODOLOGY

WATER SAMPLE COLLECTION

Purpose

The objective of the Project is to determine strengths of known sources of wastes and to obtain an accurate picture of quality at any point in the waters under study. A large number of samples were collected and analyzed to yield the physical, chemical, and bacteriological data necessary to evaluate the waste loading and water quality. A systematic system of sampling was set up to gather data from the Detroit River and tributaries, Michigan part of Lake Erie, beaches, industrial outfalls, and municipal outfalls. These samples had to be collected in the field and transported to the laboratories in accordance with accepted practice, and in numbers and time sequence that would allow optimum use of laboratory facilities.

Methods

In order to efficiently cover the large area involved and simplify scheduling, it was necessary to divide the regularly sampled stations into five groups called runs. The breakdown of these runs was essentially as follows:

Run No. 1 - Upper Detroit River

Run No. 2 - Lower Detroit River

Run No. 3 - Lake Erie

Run No. 4 - Upper Tributaries and Beaches

Run No. 5 - Lower Tributaries and Beaches

Because each of these runs could be covered in approximately five hours, the samples could be delivered to the laboratory for the immediate analyses. Runs No. 1 through 3 were taken from either the 31-foot boat or the 25-foot

boat while Runs No. 4 and 5 were taken by automobile. Sampling operations were scheduled in detail on a weekly basis and these weekly schedules were usually adhered to. Every member of the crew received a copy of the schedule which outlined specific duty assignments for each man. This method greatly decreased the amount of supervision necessary.

Identification of samples was accomplished by numbering the bottle caps by station number with a grease pencil. The bottles were usually numbered in advance and set aside in cases grouped according to run number. When the samples were collected in the field, a field record of sample number, time, and temperature was entered in the field log book. The field records of industrial waste outfall grab samples were kept on separate sheets. Figure 1 shows one such sheet with the field data filled in. These sheets were given to the crew with the outfalls to be sampled designated by means of a check mark. This method allowed a great flexibility in scheduling and eliminated a great deal of paper work. The samplers could then fill in the sheets as the samples were collected and bring the sheets back to the office where they were filed in the fireproof cabinet. In the laboratory, the field crews poured the samples into other bottles and assigned each sample a laboratory number. This laboratory number along with the field number and field data was entered on laboratory data sheets resulting in one laboratory sheet for each sample.

On regular sampling runs, the type of samples collected were chemical and bacteriological grab samples. These samples were collected using "scoop sampler" when working from a boat or a "bridge sampler" for bridge work. By wading out from the shore, the crews could reach all the beach sampling stations. Most of the tributary stations could be sampled from bridges. To reach the

river and lake stations, elementary navigation, involving landmarks or compass bearings and time and distance computations at known speeds were required.

River Sampling

The following procedure was used for sampling a particular range in the Detroit River. As the boat approached the starting point near the U.S. shore or west shore, the operator adjusted the engine rpm to give the boat a desired operating speed. On the basis of numerous time runs, curves of engine rpm versus boat speed, have been drawn as shown in Figure 2 and from these, the speed was selected. A speed of 10 fps was usually selected since this has proved the most practical operating speed for the majority of the ranges. When the boat rounded the turning point, the operator started his stopwatch beginning the time run. To allow for the effect of the river current, the boat proceeded across the range with its bow at a slight upstream angle. Distances were determined by multiplying the boat's speed by the time from the starting point. If the boat was traveling the usual 10 fps for example, it would reach a point 300 feet from the start in 30 seconds. When the proper time intervals were reached, the boat operator informed the crew either by voice or by a short blast on the horn and they immediately scooped up a sample. In addition to the boat operator, there was usually a crew of two men on a sampling run; one to grab the samples and the other to handle bottles and record data. When the operation was running smoothly, the crews could take a sample every 10 seconds. In such cases, it was only necessary to cross a range once. Under rough weather conditions, however, or where there were many sampling points at short intervals, it may be necessary to cross the range twice, sampling the even numbered stations

the first time and the odd numbered stations the second. To insure that the boat was making the proper headway across each range, the operator checked his time when he passed certain known reference points, such as buoys, along or parallel to the range. These points usually checked out with surprising accuracy. If there was error, however, the operator would stop and do the complete range over again when the speed adjustment had been made.

Lake Sampling

The lake sampling was conducted using much the same procedure as in the river. In the lake, however, directions could not always be determined by visual alignment with landmarks and therefore, were usually run on the basis of compass bearings. Sampling stations are a considerable distance apart in the lake, therefore, higher boat speeds such as 30 fps were used for purposes of timing.

Industrial Sampling

In addition to regular sampling, the collection of grab samples from industrial outfalls constituted a major part of sampling activities. These samples were often hard to get due to shallow water and submerged objects near the outfalls. For this type of work the 25-foot boat and the 18-foot jet boat were used. To get a sample the boat operator noses the bow of the boat up to the outfall and a member of the crew positioned in the bow scoops the sample with an industrial waste sampler and pours it into a chemical bottle. In some cases, it was necessary to make more than one scoop and/or pass at an outfall in order to get the desired amount of chemical sample.

Bacterial samples were normally not taken at industrial outfalls. However, in cases where one was required, it was taken with the scoop sampler used in river work or with a bridge sampler. Figure 7 and figure 8 show locations of industrial waste outfalls. Industrial and domestic sampling surveys are described in Section II.

Depth Sampling

To verify that surface samples would truly represent the water quality at the various sampling points in the study area, a number of samples were taken at various depths as well as at the surface. Types of samples collected at depths included chemical, bacteriological, and dissolved oxygen samples. The bacteriological samples were collected at depths using the J.Z. Aseptic bacteriological collection device, which is described in the equipment descriptions. Chemical samples were collected with a Kemmerer Water Sampler.

Dissolved Oxygen Sampling

Dissolved oxygen samples were taken not only during depth sampling work but also in other instances. These were collected with either an American Public Health Association sewage sampler or a Kemmerer sampler. When the Kemmerer sampler was used, it had a rubber delivery tube on it. This tube was inserted so that it ran to the bottom of the bottle. In either case, the 250 cc. bottle was overflowed at least twice its capacity. The American Public Health Association sampler is built for this purpose and does this automatically. In the case of the Kemmerer sampler, this was accomplished by timing the flow.

INDUSTRIAL WASTE SAMPLING SHEET
(All listed as going upstream)

SOURCE DETROIT R		SIZE	SAMPLE DATA #	TIME	TEMP
McLouth (G)	1				
Chry (Cyr)	1	ditch			
Chry (Amp)	1				
Shawinigan	1	24"			
Monsanto	1	15-6"			
Chry (Fr)	1	S			
Mobil Oil	1	S			
McLouth (T)	1	4"	✓ W1	1800	32.0
	2	24"	✓ W2	1800	37.0
	3	1[illegible]"	✓ W3	1800	50+
	4	4"	✓ W4	1800	32.5
Firestone	1	24"			
	2	S			
Drain #5	1	S			
Pennsalt	1	4'F	✓ W5	1800	33.0
	2	5'F	✓ W6	Outfalls i[illegible]	
	3	24"	✓ W7	and [illegible]	
	4	5'	✓ W8	1900	30.0
Koppers	1	12"			
Wye St	1	3'F	✓ W9	1900	30.5
Wy Chem (S)	1	3'F	✓ W10	1900	32.5
	2	5'F	✓ W11	1900	37.0
	3	5'F			
	4	S			
	5	ditch			
Wy Chem (?)	1	F	✓ W12	1900	36.0
	2	S			
	2A	S			
	3	3'F	✓ W13	1900	37.5
	4	24"			
	4A	S			
du Pont	1	1"			
GIS (Roll)	1	4'F			
	2	sewer			
	3	sewer			
	4	sewer			
	5	12"			

SOURCE DETROIT R		SIZE	SAMPLE DATA #	TIME	TEMP
	6	12"			
	7	4"			
	8	15"			
	9	15"			
	10	15"			
	11	4'			
(McSip)	12	24"			
(McSip)	13	1[illegible]"			
Dana	1	1[illegible]"			
Fuel Oil	1	ditch			
GIS (Strip)	1	5'F			
	2	5'F			
AC (Solv) 1	1	pond ✓	W14	1900	50+
GIS (Han) 2	1	1[illegible]"			
	2	5'F			
[illegible] by Ship	3	2'F			
[illegible]	4	4'F			
	5	2'F			
	6				
	7	F			
	8	30"			
	9	3"			
	10	4"			
	11	30"			
Schroeder	1	36"			
	2	36"			
Revere	1				
	2				
	3				
McKinstry	1	5'			
Parke Davis	1	24"	✓ W15	2000	25.0
	2	24"	✓ W16	2000	29.0
	3	24"	✓ W17	[illegible]	30.5
U.S. Rubber	1	F			
	2	[illegible]			

SOURCE ROUGE R		SIZE	SAMPLE DATA #	TIME	TEMP
AC(Gen)	1	24"			
	2	30"			
Tanks	1	6"			
Peerless	1	15"			
	2	12"			
AA Chem	1	bank			
	2	[illegible]			
	3	[illegible]			
	4	[illegible]"			
Tailrace	1	S			
Rulo Cr	1	mouth			
Fd Rg Pl	1	weirs			
Fd Fndry	1	36"			
Fd Bks	1	5'			
Fd Lev	1	18"			
Old Channel					
AC(Solv)	1	15"			
	2	15"			
	3	12"			
Scott	1				
Peerless	1	3'F			
AC (Plas)	1	15"			
AC (S-P)	1	1[illegible]"			
	2	15"			
	3	2'F			
AC (S-S)	1	bank			

Date *Sunday 7-25-63*
Sampler *S. Hendricks, B Yadesy*
Weather *Light Rain*

Air Temp *92°F*
No. Samples Taken *15*
Extra Samples Taken for Gi[illegible]

IV

FIGURE I

5-A

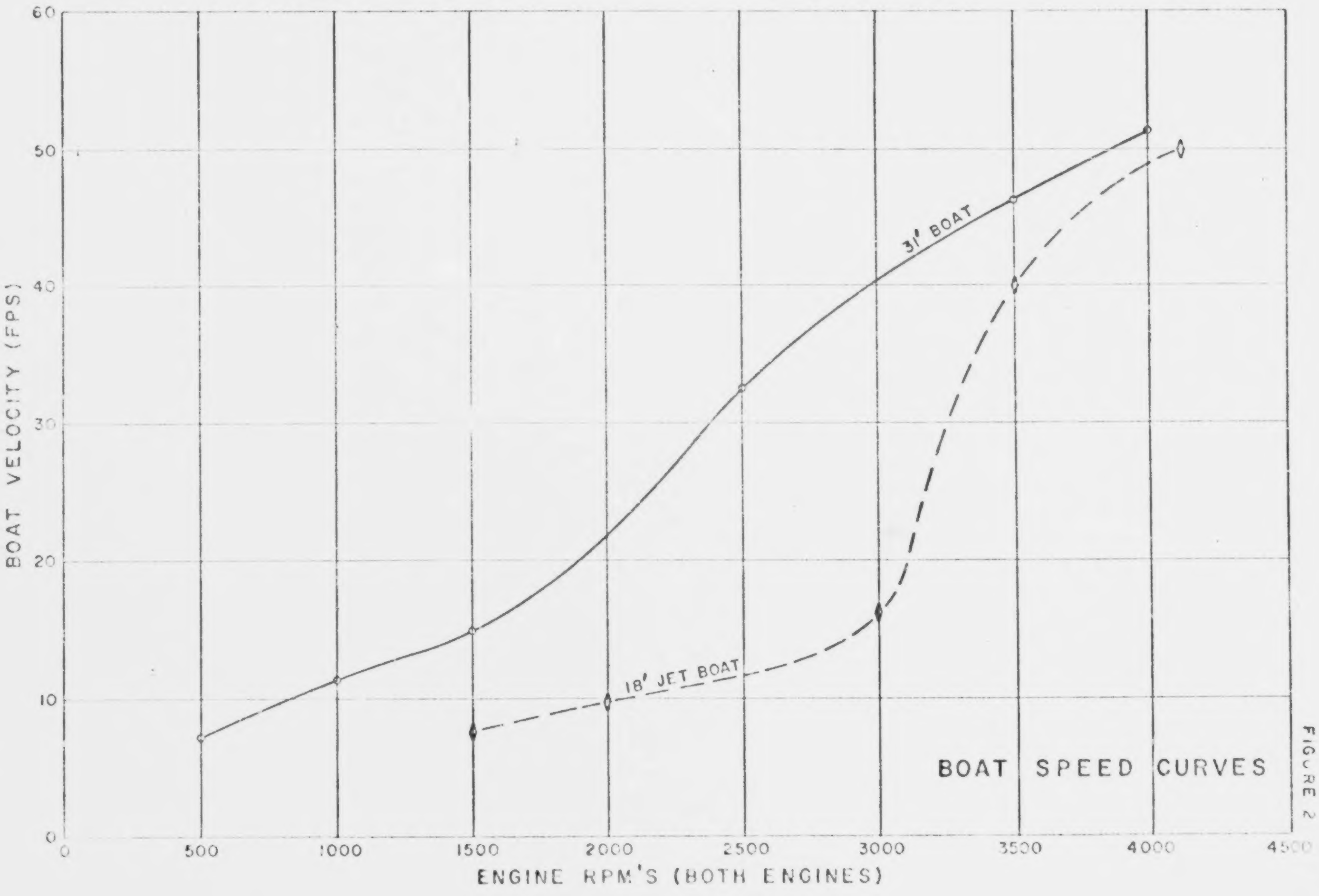

BOAT SPEED CURVES
BOAT VELOCITY (FPS)
ENGINE RPM'S (BOTH ENGINES)
31' BOAT
18' JET BOAT
0
10
20
30
40
50
60
0
500
1000
1500
2000
2500
3000
3500
4000
4500

FIGURE 2

Compositing Samples

On many occasions 12, 16 and 24-hour composite samples were analyzed. These composite samples enabled the Project to obtain results more representative of an average from fewer analyses. Some of the compositing was done in the field, but the majority of it was done at the laboratory in the following manner. Composites were usually limited to chemical samples only which were collected on three shifts by three different crews. At the end of each shift, the crew would return to the laboratory with all the samples in chemical collection jars. When the crew from the last shift for the day came in, they would do the compositing. This consisted of taking the individual samples from each station, usually 3 to 6 full 2-quart chemical jars, and pouring their contents into the 3-gallon wide-mouth pouring jug. After shaking the jug to assure adequate mixing, the laboratory bottles were filled from it.

Preservation of Samples

Many of the samples could not be analyzed immediately after collection and required certain preservative measures. Chemical samples usually required no preservation as they could be held over for a few days. Certain of the chemical analyses were performed in Chicago (Great Lakes-Illinois River Basins Project laboratories) because the Project's laboratory was not equipped to do them. In this case, half of the sample (2 quarts) was preserved by adding 20 ml of HNO_3 solution (strength 1:1) to it. This was done in the laboratory by the field crews when they poured the samples from collection jars into bottles for analyses. Bacteriological samples were all iced immediately after collection and analyses on them were performed within 24 hours. Dissolved

oxygen samples were all fixed in the field immediately after collection in accordance with the method prescribed on page 310 of "Standard Methods" (11th Edition, American Public Health Association, N.Y.).

Safety

No sample is important enough to warrant risking a life or possible injury due to an accident, therefore, the exercising of safety precautions takes priority over everything else. Since sampling from boats usually carried on during all types of weather and water conditions, the crews had to be especially concious of the safety measures which they were to employ.

The first step towards safety was to make the boats as safe as possible. This was accomplished by having thoroughly experienced boat operators at the helm, and maintaining the necessary safety gear such as: lights, horn, life jackets, fire extinguishers, distress flares, extra line, and a radio on board. The two larger boats were equipped with twin engines to decrease the possibility of power failure at a critical time. All the crew members were also made thoroughly familiar with the set of safety regulations drawn up specifically for the Project's boats. These safety regulations are divided into general rules for crew members and passengers and additional rules for crew member only, as follows:

Rules for Crew Members and Passengers

1. Boat capacities not to be exceeded, except in emergencies, are:

    a. When sampling activities occur during run:

        (1) 3 passengers and 3 crew on 31' boat
        (2) 3 passengers and 3 crew on 25' boat
        (3) 2 crew and 1 passenger on 18' jet boat
        (4) 2 crew on 14' utility
        (5) 2 crew on 9' pram

b. When no sampling activities occur during run:

(1) 12 passengers and 3 crew on 31' boat
(2) 6 passengers and 2 crew on 25' boat
(3) 2 crew and 3 passengers in 18' jet boat
(4) 3 crew on 14' utility
(5) 2 crew on 9' pram

2. All crew members should wear soft rubber soled shoes. Others in office should wear them if they know in advance of a scheduled trip.

3. No smoking during fueling or while engines are being started.

4. Life preservers shall be:

a. Worn by:

(1) All persons aboard at all times if conditions warrant. (This decision to be made by boat operator.)
(2) All persons while in the process of sampling, working over the side of the boat, or on the bow while boat is in motion.
(3) All hands in 9' pram, always.

b. In sufficient supply so that there is at least one life preserver for each person on board.

c. Kept clean.

5. No person shall climb up onto flying bridge on 31' boat while boat is in motion. Walking or other movement on boat decks and bridge is discouraged and should be held to a necessary minimum. Everyone must be seated while the boat is proceeding at full throttle.

6. Care should be used in getting in and out of the boats.

7. No hands or arms should be over the side of the boat except when sampling. This is especially true when approaching or leaving a dock.

8. No sitting on bow, or side and stern gunwales.

9. If you ever capsize, remember, that if the boat continues to float, it is best to remain with it. You are more easily located by a search plane or boat.

Additional Rules for Crew Members:

1. Minimum crew should consist of three men (including the boat operator) during regular work operations or two men on short trips.

2. At least one life ring buoy with line attached should be conveniently located within the work area of each boat.

3. A first aid kit must be on each boat and at least one crew member must be able to administer first aid - including artificial respiration.

4. All crew members should understand the operation of fire extinguishers, flares, and radio, as well as being able to take over the wheel in emergencies.

5. Conditions under which the boat will not go out or cease sampling operations:

   a. Under adverse weather (to be decided by boat operators).
   b. Boats will be pulled out when ice conditions warrant it.
   c. No run without boat operator except in emergencies.

6. Crew members shall not cast off lines until the boat operator gives the command.

7. The boats will abandon sampling operations to aid any vessel in distress and obey the Rules of the Road and all U.S. Coast Guard regulations.

8. Keep an alert lookout. Serious accidents have resulted from failure in this respect.

9. Watch your wake. Pass through anchorages only at minimum speed.

10. Keep firefighting and lifesaving equipment in good condition and readily available at all times.

11. Know your fuel tank capacity and cruising radius. If necessary to carry additional gasoline, do so only in proper containers and take special precautions to prevent the accumulation of such vapor in confined spaces.

12. Good housekeeping is even more important afloat than ashore. Cleanliness diminishes the probability of fire.

13. Consider what action you would take under various emergency conditions - man overboard, fog, fire, a stove-in plank or other bad leak, motor breakdown, bad storm, collision.

14. Have an adequate anchor and sufficient cable to assure good holding in a blow (at least six times operating depth).

15. Eliminate tripping hazards where possible, make conspicuous those which must remain, have adequate grab-rails.

16. Always have a chart (or charts) of your area on board.

17. Keep electrical equipment and wiring in good condition. No knife switches or other arcing devices should be in fuel or engine compartments.

18. Check your fuel supply system; see that the tanks are vented outboard, that the fill pipes which are located outboard of coaming extend to the bottom of the tank. Have an adequate filter on the fuel line.

In addition to the boating safety regulations, there were many other safety considerations.

Daily weather forecasts were received from the Naval Air Station's Weather Station at the beginning of each working day. These warned the boat operators of any dangerous conditions which were likely to arise while they were out sampling.

Samplers were made thoroughly familiar with the hazards in each piece of equipment before it was put to use. Whenever the crews had to set foot on private property, such as railroad bridges, permission was first obtained from the owner or custodian. Outfall sampling also required extra precautions such as careful vigilance of waves from passing boat traffic which might throw the sampling craft on rocks or against a dock. Bridges were convenient sampling points, but traffic hazards were great. Precautions, such as not parking on the bridge itself and making good use of vehicle lights when stopped, helped to minimize dangers in bridge sampling.

In general, the fact that no major accidents occurred during the Project's sampling activities can be credited largely to the extensive safety precautions exercised by the Project's personnel.

Location

Detroit River

The selection of sampling points on the Detroit River was influenced by such factors as the location of known pollution sources, the flow characteristics, and the location of points used by the International Joint Commission. Comparison of the Detroit River-Lake Erie Project's results with those gathered by the International Joint Commission, whose data dates back as far as 1913, was desired. This was the reason for selecting many of the same ranges and points.

A mileage index system was used for the purpose of identifying the location of sampling ranges on the river and its tributaries. This system involves the use of one or more letters in identifying the stream followed by a number which represents the distance in river miles from the mouth or other point of reference. In the case of the Detroit River, the reference point is the Detroit River Light opposite Pointe Mouillee, which is the zero mileage point established by the U.S. Army Corps of Engineers. The designation Dt 30.8 for example, refers to a range on the Detroit River approximately 30.8 miles from the mouth and the designations DtCn, DtRg, DtEr, and DtMo refer to ranges on Conners Creek, Rouge River, Ecorse River and Monguagon Creek, respectively. In the Detroit River there are 154 sampling points located on 15 ranges as shown on the map (Figure 3). These sampling points or stations are numbered from R1 to R154 and are listed as follows:

Range	Description	Sample No.	Ft. from U.S. Shore or West Bank
DT 20.6	Above Rouge River from Delray Detroit Edison Dock to Canadian Industries Ltd., Dock	R1	5
		R2	20
		R3	50
		R4	100
		R5	200
		R6	300
		R7	400
		R8	500
		R9	600
		R10	700
		R11	1,000
		R12	1,500
		R13	1,800
		R14	2,000
		R15	2,200
		R16	2,300
DT 19.0	NE Corner - Great Lakes Steel Strip Mill to Canadian Shore	R139	100
		R140	200
		R141	300
		R142	400
		R143	800
		R144	1,000
		R149	1,500
		R150	2,000
		R151	2,200
		R152	2,300
		R153	2,400
		R154	2,500
DT 17.4W	Ecorse Light to Head of Fighting Island	R17	100
		R18	200
		R19	400
		R20	600
		R21	800
		R22	1,000
		R23	1,200
		R24	1,400
		R25	1,600
		R26	1,900
		R27	2,200
DT 17.0E	Fighting Island to LaSalle Oil & Coal Co. Slip	R28	100
		R29	400
		R30	700
		R31	900

Range	Description	Sample No.	Ft. from U.S. Shore or West Bank
DT 14.6W	Wyandotte City Power Plant & Water Works Dock, over intake and through cut to Fighting Island	R32	20
		R33	100
		R34	200
		R35	300
		R36	400
		R37	600
		R38	800
		R39	900
		R40	1,000
		R41	1,100
		R42	2,000
		R43	2,300
		R44	3,000
		R45	4,000
DT 12.0W	Trenton Channel Toll Bridge from U.S. Mainland Shore to West Shore, Grosse Ile	R86	122
		R87	322
		R88	490
		R89	670
		R90	880
DT 9.6W	O. C. Howey Boat Dock on U.S. Mainland to West Shore Country Club on Grosse Ile	R145	100
		R146	300
		R147	500
		R148	900
DT 9.3E	Grosse Ile to Canadian Shore above Stony Island	R46	100
		R47	200
		R48	500
		R49	800
		R50	1,200
		R51	1,500
		R52	2,000
		R53	2,500
		R54	3,000
		R55	3,300
		R56	3,600
		R57	4,000
		R58	4,500
		R59	4,800
		R60	5,000
		R61	5,300
		R62	5,600
		R63	5,800

Range	Description	Sample No.	Ft. from U.S. Shore or West Bank
DT 8.7W	Trenton Channel County Bridge from U.S. Mainland to West Shore, Grosse Ile	R91	80
		R92	280
		R93	480
		R94	680
		R95	980
		R96	1,240
DT 3.9	Maple Beach above Huron River outlet to Sunset Beach, Bar Point	R64	500
		R65	1,500
		R66	2,500
		R67	3,500
		R68	4,500
		R69	5,500
		R70	6,500
		R71	7,500
		R72	8,500
		R73	9,500
		R74	10,500
		R75	11,500
		R76	12,500
		R77	13,500
		R78	14,500
		R79	15,000
		R80	16,200
		R81	16,500
		R82	17,500
		R83	18,500
		R84	19,000
		R85	19,300

Range	Description	Sample No.	Ft. from U.S. Shore or West Bank
Dt 30.8W	Windmill Pointe to head of Peach Island	R97	20
		R98	100
		R99	200
		R100	300
		R101	400
		R102	500
		R103	700
		R104	1,000
		R105	2,000
		R106	2,500
Dt 30.7E	Peach Island to Canadian Shore at head of Detroit River	R107	100
		R108	300
		R109	500
		R110	700
		R111	850
		R112	900
		R113	980
Dt 28.4	Waterworks Park Coal Dock to Detroit Yacht Club Dock, Belle Isle	R114	100
		R115	200
		R116	300
		R117	400
		R118	700
		R119	1,000
		R120	1,300
		R121	1,500
Dt 26.8W	Belle Isle Bridge	R131	52
		R132	169
		R133	292
		R134	421
		R135	689
		R136	1,094
		R137	1,478
		R138	1,903
Dt 25.7	U.S. Engineers Warehouse to Hiram Walker & Sons Ltd., Canada	R122	50
		R123	100
		R124	300
		R125	600
		R126	1,000
		R127	2,000
		R128	2,600
		R129	3,200
		R130	3,400

Lake Erie

Sampling points in the Michigan waters of Lake Erie were selected after taking into consideration such factors as tributaries, beach areas, lake surface area, boundaries, wind variations and possible current variations. Here, as in the river, the sampling points are on fixed ranges. Many of the 14 ranges are identical to those established by the International Joint Commission in its 1947 study of the area. There are 28 lake stations at various locations labeled L1 through L28. These locations are listed as follows but ~~are~~ probably best explained by the map (Figure 3).

Station Description	No.
Range A to B	
4,000 ft. (Buoy 28)	L1
12,000 ft. (Buoy 13)	L2
Range B to Milleville Beach	
10,000 ft.	L21
Range B to shore	
3,580 ft.	L3
10,700 ft.	L4
Range B to H	
4,800 ft. (Buoy 7 & 8)	L5
14,400 ft. (Buoy 3 & 4)	L6
Range I4 to LB	
11,000 ft.	L22
Range H to shore	
6,650 ft.	L7
20,000 ft.	L8
Range H to R	
9,800 ft.	L9
29,400 ft.	L10
Range R to Stony Point	
5,850 ft.	L11
17,500 ft.	L12

Station Description	No.
Range R to Raisin River	
8,250 ft. (Buoy 3 & 4)	L15
16,500 ft. (Buoy 7 & 8)	L27
21,600 ft. (Buoy 9 & 10)	L28
Range Stony Point to Raisin River	
5,600 ft.	L23
16,800 ft.	L24
Range R to shore below Plum Creek	
7,200 ft.	L13
21,600 ft.	L14
Range R to C	
10,940 ft.	L17
32,800 ft.	L18
Range L20 to L14	
11,000 ft.	L25
33,000 ft.	L26
Range C to shore	
7,070 ft.	L19
21,200 ft.	L20

Beaches

The 31 beach sampling stations listed here were picked so that they could be sampled either by car or from a small boat. Stations are numbered B1 through B31 and are shown on the map of the Lake (Figure 3).

Station Description	Name	No.
Position: 42°-03'-06"N, 83°-11'-06"W. 150' offshore - 100' south of Troyon Road off Erie Drive.	Maple Beach	B1
Position: 42°-02'48"N, 83°-11'-06"W, 200 ft. offshore 20' south of Longdon Road off Erie Drive.	Milleville Beach	B2
Position: 41°-59'-09"N, 83°-13'-35"W, 150' offshore opposite house No. 7880 Lake Shore Drive on the northern end of beach.	Estral Beach	B3
Position: 41°-58'-40"N, 83°-14'-18"W, 100'offshore from small sand strip used as resident bathing beach next to house No. 6792 Lake Shore Drive.	Estral Beach	B4
Position: 41°-56'-30"N, 83°-15'-39"W, 100' offshore in line with chain link fence which divides the privately owned Stony Point Park from the free access beach along Dewey Road.	Dewey Beach	B5
Position: 41°-56'-25"N, 83°-15'-40W, 100 ft. offshore 200 ft. south of the face brick gate wall that crosses Dewey Road.	Dewey Beach	B6
Position: 41°-56'-20"N, 83°-18'-35"W, 150' offshore in line with Cloverdale Road.	Woodland Beach	B7
Position: 41°-56'-15"N, 83°-18'-45"W, 150' offshore midway between Oakwood & Woodland Blvd. off Parkwood Street.	Woodland Beach	B8

Station Description	Name	No.
Position: 41°-56'-13"N, 83°-18'-52"W, 150 ' offshore midway between Beechwood and Elmwood Street.	Woodland Beach	B9
Position: 41°-56'-05"N, 83°-18'-56"W, 150' offshore in line with North Grove Road which intersects Lakeshore Drive in the Grand Beach properties.	Willow Beach	B10
Position: 41°-56'-02"N, 83°-19'-00"W, 150' offshore off Lakeshore Drive midway between B10 and B12 locations in line with Grandview Blvd.	Willow Beach	B11
Position: 41°-55'-58"N, 83°-19'-08"W, 150' offshore in line with South Grove Road which intersects with the southern end of Lakeshore Drive in Grand Beach property.	Willow Beach	B12
Position: 41°-55'-53"N, 83°-19'-11"W, 150' offshore of Kress Park in line with the midpoint of Kress Park Bathing Beach approximately 300' south of South Grove Road.	Willow Beach	B13
Position: 41°-55'-50"N, 83°-19'-12"W, 150' offshore in line with Monrona Drive which intersects the northern end of Edgewater Blvd. in Detroit Beach.	Detroit Beach	B14
Position: 41°-55'-46"N, 83°-19'-20"W, 150' offshore in line with 8th Street at the point where it intersects Edgewater Blvd.	Detroit Beach	B15
Position: 41°-55'-38"N, 83°-19'-27"W, 150' offshore in line with 4th Street at the point where it intersects Edgewater Blvd.	Detroit Beach	B16
Position: 41°-55'-30"N, 83°-19'-35"W 150' offshore in line with Grand Blvd. which intersects the southern end of Edgewater Blvd. in Detroit Beach.	Detroit Beach	B17

Station Description	Name	No.
Position: 41°-55'-17"N, 83°-19'-39"W, 100' offshore 200' from pilings at the north end of the park offshore from the turning loop on the Beach Trail.	Sterling State Park	B18
Position: 41°-55'-02"N, 83°-19'-43"W, 100' offshore in line with the concession stand on the beach.	Sterling State Park	B19
Position: 41°-54'-43"N, 83°-19'-50"W, 150' offshore 1600' south of the concession stand on the beach.	Sterling State Park	B20
Position: 41°-54'-21"N, 83°-19'-57"W, 150' offshore 500' north of the pilings on the southern end of the beach.	Sterling State Park	B21
Position: 41°-52'-02"N, 83°-22'59"W, 100' offshore in line with Main Road where it intersects Lake Erie.	Bolles Harbor	B22
Position: 41°-51'-33"N, 83°-23'-25"W, 100' offshore in line with Lighthouse Blvd. where it hits Lake Erie.	Bolles Harbor	B23
Position: 41°-51'-10"N, 83°-23'-45"W, 100' offshore in line with the LaPlaisance Rd.-Lavigne Rd. intersection.	North Otter Creek Beach	B24
Position: 41 -50'-52"N, 83°-24'-55"W, 100' offshore 700' north of Otter Creek where it flows into Lake Erie.	North Otter Creek Beach	B25
Position: 41°-50'-39"N, 83°-24'-[illegible]"W, 100' offshore 300' south of Otter Creek where it flows into L[illegible]e.	South Otter Creek Beach	B26
Position: 41°-50'-22"N, 83°-24'-14"W, 100' offshore in line with South Otter Creek Road where it runs into Lake Erie.	South Otter Creek Beach	B27
Position: 41°-50'-00"N, 83°-24'-25"W, 100' offshore 2,400' south of point where South Otter Creek Road hits Lake Erie.	Toledo Beach	B28
Position: 41°-49'-[illegible]"N, 83°-24'-43"W, 100' offshore 100' south of pilings at the northern end of the picnic ground amusement-beach area.	Toledo Beach	B29

Station Description	Name	No.
Position: 41°-48'-50"N, 83°-25'-58"W, 100' offshore in line with Allen Cove Road at the point where it intersects Lake Erie.	Luna Pier	B30
Position: 41°-48'-32"N, 83°-26'-28"W, 100' offshore in line with Luna Pier Road where it runs into Lake Erie.	Luna Pier	B31

Coordinates are taken from U.S. Lake Survey Corps of Engineer's Chart #37 and 41.

Tributaries

Selection of sampling points on the tributaries was largely governed by the locations of bridges, since nearly all tributary sampling was done from bridges. The T indicates a tributary sample and the number indicates the exact location. Each tributary has been assigned certain station numbers, some of which have not been sampled as yet, but are designated for possible future sampling. Unless otherwise stated in the location description, the sampling points are located at midstream. The following is a list of these sampling points by tributary.

Station Location	Station No.
Conners Creek (Nos. T1 through T4)	
Conners Creek 0.3 miles up from mouth, 20' from right bank	T1
Conners Creek 0.3 miles up from mouth, 40' from right bank	T2
Conners Creek 0.8 miles from mouth, 20' from right bank	T3
Conners Creek 0.5 miles from mouth, 40' from right bank	T4

Station Location	Station No.
Rouge River (Nos. T10 through T27)	
Rouge River (middle of stream)	T10
DT&IRR bridge over new channel, 0.37 miles upstream from mouth, 50' from right bank	T11
DT&IRR bridge over new channel, 0.37 miles upstream from mouth, 150' from right bank	T12
At RR Bridge to Zug Island by intersection of White St. & Jefferson St. west in old channel 0.81 miles from Detroit River	T13
In old Zug Island channel at DT & IRR bridge on north side of Zug Island, 0.33 miles from Detroit River.	T14
At Jefferson St. west 1.09 miles upstream from Detroit River.	T15
At NYC RR bridge 1.47 miles upstream from Detroit River.	T16
At Wabash RR bridge 1.87 miles upstream from Detroit River	T17
At Fort St. bridge 2.19 miles upstream from Detroit River	T18
At Dix Ave. bridge 2.75 miles upstream from Detroit River	T19
At Schaefer Road bridge, 3.87 miles upstream from Detroit River	T20
At Greenfield Road bridge 5.02 miles upstream from Detroit River	T21
At DT&IRR bridge next to I-94 Expressway 5.28 miles upstream from Detroit River	T22
At Rotunda Drive bridge 6.34 miles upstream from Detroit River	T23

Station Location	Station No.
At Michigan Avenue bridge 8.13 miles upstream from Detroit River	T24
At South Military Road bridge on Lower Rouge River 10.37 miles upstream from Detroit River	T25
At Ford Road bridge 10.83 miles upstream from Detroit River	T26
At Southfield Road bridge 7.5 miles upstream from Detroit River	T27

Ecorse River (Nos. T31 through T41)

Station Location	Station No.
Ecorse River (middle of stream) At Jefferson 0.08 miles up from Detroit River	T31
At west side of D&T SLRR bridge in line with Alfred St. 0.2 miles up from Detroit River	T32
On South branch at Emmons Blvd. 0.9 miles up from Detroit River	T33
On South branch at Gohl St. 1.8 miles from Detroit River	T34
On South branch at Fort St. 3.0 miles from Detroit River	T35
On South branch at Dix Road 3.9 miles up from mouth	T36
On North branch at Mill St. [illegible] miles up from Detroit River	T37
On North branch at Southfield Road 1.3 miles up from mouth	T38
On North branch at Empire Avenue 2.1 miles up from Detroit River	T39
On South branch at Fort Street 2.8 miles up from Detroit River	T40
On North branch at Dix Road 3.6 miles up from Detroit River	T41

Station Location	Station No.
Monguagon Creek (Nos. T46 through T49)	
Monguagon Creek (middle of creek) At Biddle, 0.5 miles up from Detroit River	T46
Off rail siding bridge closest to Pennsalt's West Side Plant, 0.82 miles up from Detroit River	T47
At D&T SLRR where Huntington Creek empties in	T48
Where Huntington Creek flows in ditch approximately 2,000 ft. west of Quarry Road	T49
Huron River (Nos. T55 and T56)	
Huron River at River Road, middle of stream, 2.1 miles upstream from Detroit River	T55
Huron River at Fort St. in Rockwood, middle of stream, 4.8 miles upstream from Detroit River	T56
Swan Creek (No. T65)	
Swan Creek at River Road, middle of stream, 2.8 miles upstream from Lake Erie.	T65
Stony Creek (No. T70)	
Stony Creek at River Road, middle of stream, 0.6 miles upstream from Lake Erie.	T70
Sandy Creek (No. T75)	
Sandy Creek at River Road, middle of stream, 1.0 miles upstream from Lake Erie	T75
Raisin River (Nos. T80 through T90)	
Raisin River (middle of stream) at mouth, between buoys 11 and 12	T80

Station Location	Station No.
0.5 miles upstream from mouth approximately 600 ft. downstream from channel connecting Raisin River with Plum Creek Bay	T81
1.13 miles upstream from mouth, approximately 500 ft. downstream from turning basin between blackcan buoys 15 and 13	T82
1.56 miles upstream from mouth, approximately 400 ft. downstream from creek entering on the left	T83
1.95 miles upstream from mouth under I-75 Expressway bridge	T84
3.0 miles upstream from mouth at Winchester Road Bridge	T85
3.40 miles upstream from mouth at Macomb Street bridge	T86
3.55 miles upstream from mouth at N. Monroe Street bridge	T87
4.25 miles upstream from mouth at Roessler Street bridge	T88
4.8 miles upstream from mouth at Telegraph Road bridge	T89
13.50 miles upstream from mouth at Ida Maybee Road bridge	T90

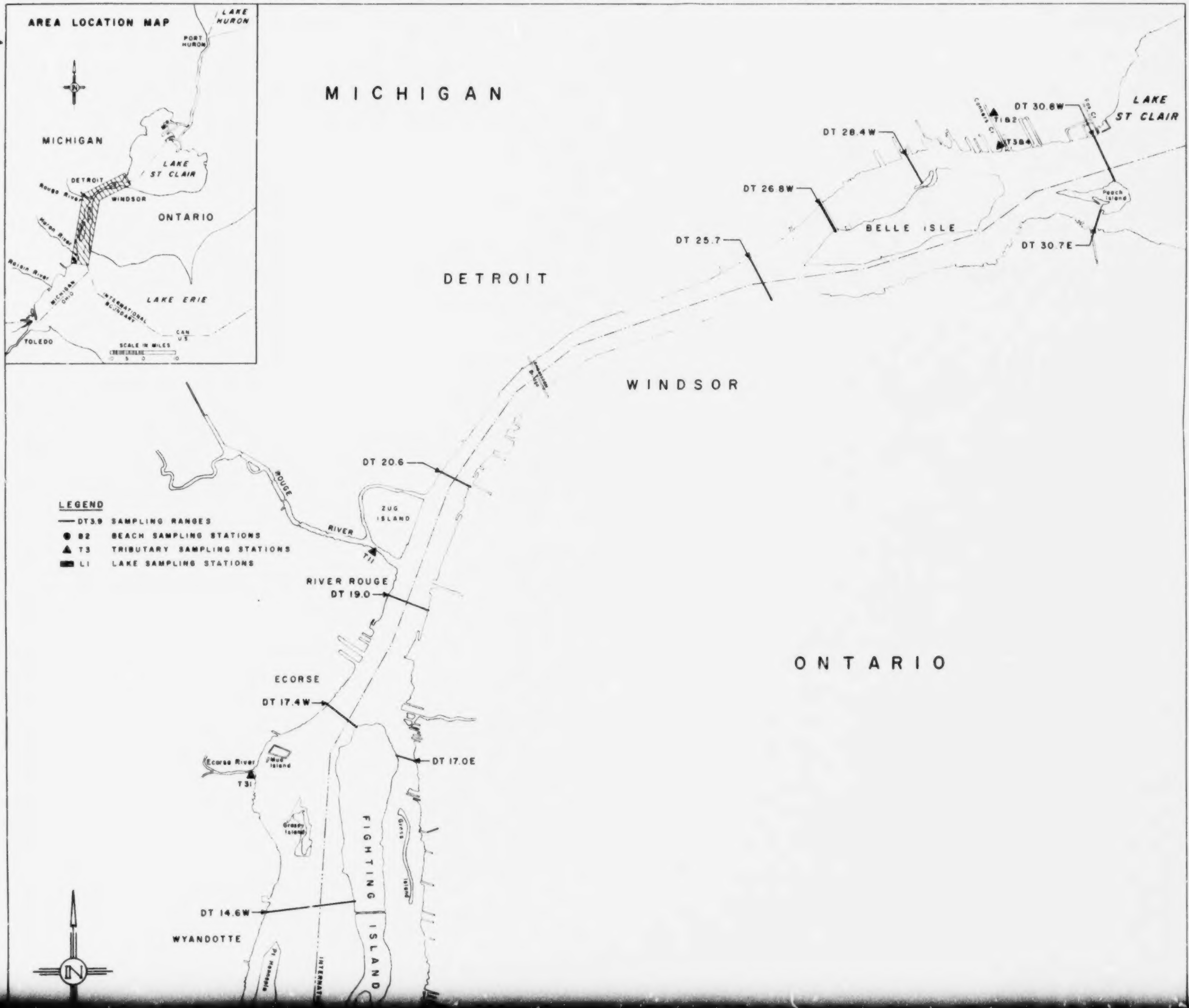
Plum Creek (No. T95)

Plum Creek 2.8 miles from mouth, middle of stream at Kentucky Avenue	T95

LaPlaisance Creek (No. T101)

LaPlaisance Creek 0.8 miles from mouth, middle of stream at LaPlaisance Road	T101

A



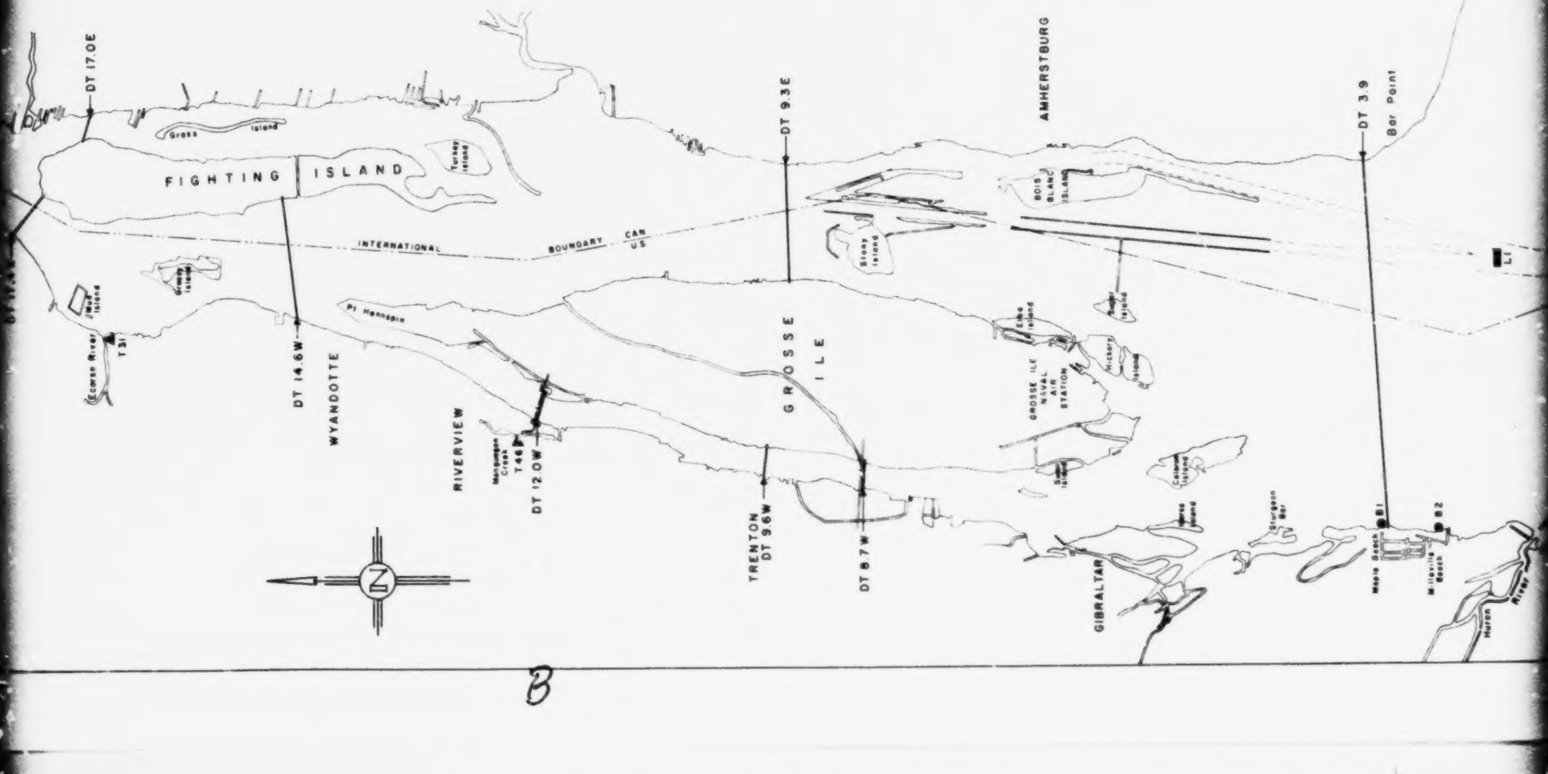
AREA LOCATION MAP
LAKE HURON
PORT HURON
MICHIGAN
LAKE ST CLAIR
DETROIT
WINDSOR
ONTARIO
Rouge River
Huron River
Raisin River
MICHIGAN OHIO
INTERNATIONAL BOUNDARY
LAKE ERIE
CAN U.S.
TOLEDO
SCALE IN MILES
MICHIGAN
DETROIT
WINDSOR
ONTARIO
LAKE ST CLAIR
DT 30.8W
DT 30.7E
Peach Island
DT 28.4W
T1&2
T3&4
Conners Cr
Fox Cr
DT 26.8W
BELLE ISLE
DT 25.7
DT 20.6
ZUG ISLAND
ROUGE
RIVER
T11
RIVER ROUGE
DT 19.0
ECORSE
DT 17.4W
DT 17.0E
Ecorse River
T31
Mud Island
Grassy Island
FIGHTING ISLAND
Grass Island
DT 14.6W
WYANDOTTE
Pt Hennepin
INTERNAT
LEGEND
DT3.9 SAMPLING RANGES
B2 BEACH SAMPLING STATIONS
T3 TRIBUTARY SAMPLING STATIONS
L1 LAKE SAMPLING STATIONS
N

DETROIT

LOCATION

U.S. DEPARTMENT

REGION



B

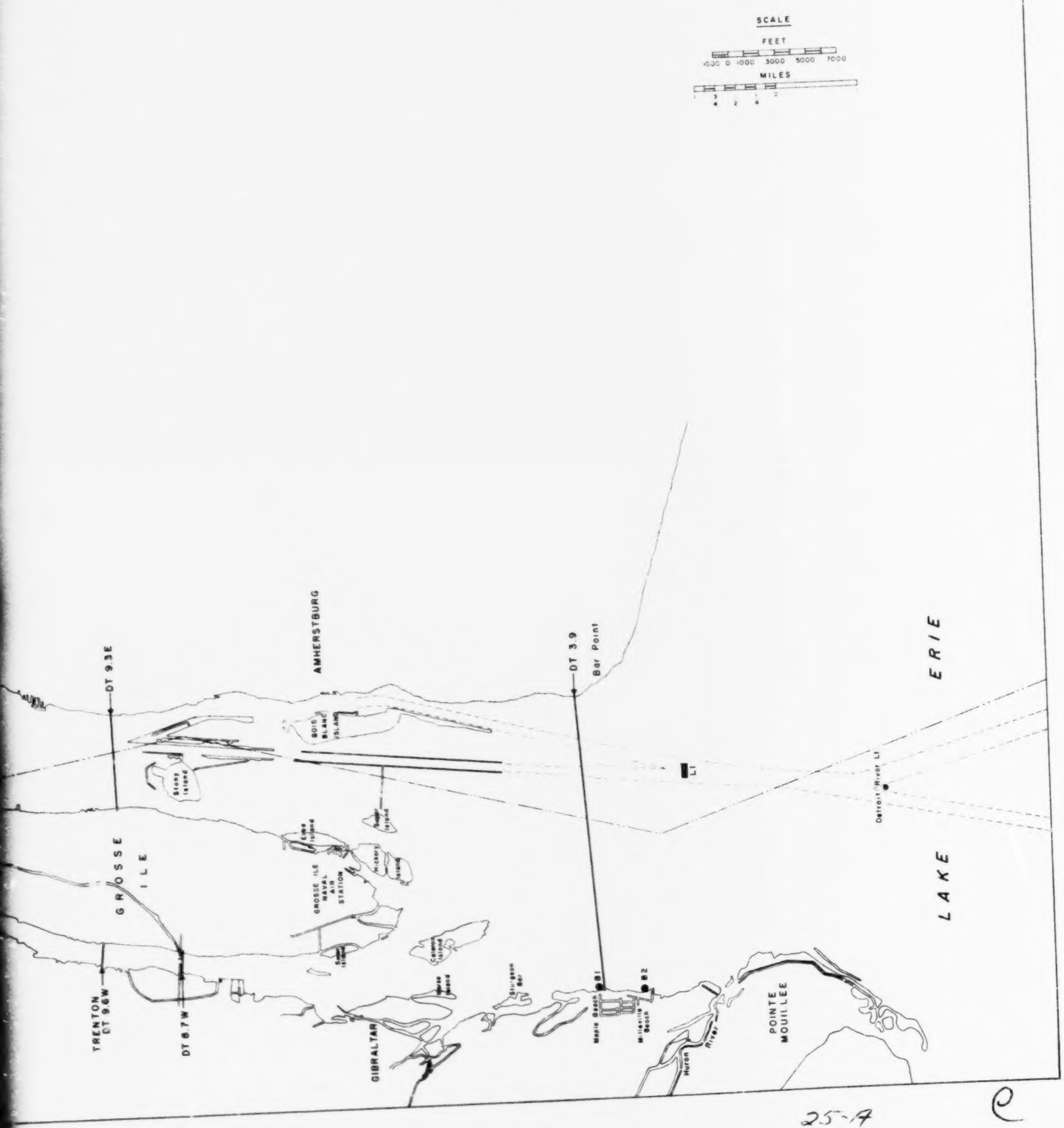
FIGURE 3

DETROIT RIVER–LAKE ERIE PROJECT

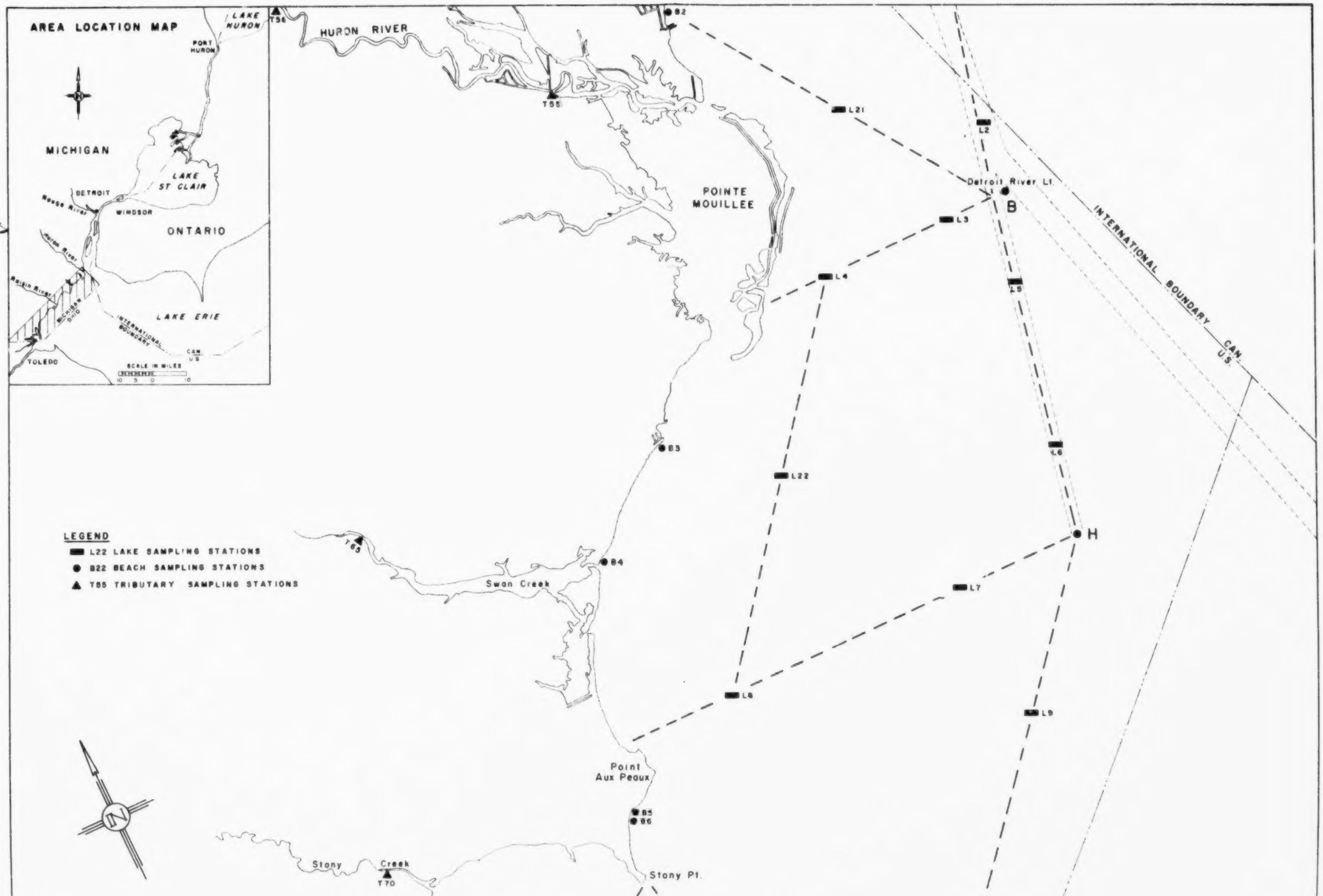
LOCATION OF SAMPLING STATIONS

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



25-A


AREA LOCATION MAP
LAKE HURON
PORT HURON
MICHIGAN
LAKE ST CLAIR
DETROIT
WINDSOR
ONTARIO
LAKE ERIE
TOLEDO
INTERNATIONAL BOUNDARY
SCALE IN MILES
HURON RIVER
T56
T55
B2
L21
L2
Detroit River Lt.
B
L3
L4
L5
L6
L7
L8
L9
L10
L11
L12
L22
L23
L24
H
POINTE MOUILLEE
INTERNATIONAL BOUNDARY
CAN.
U.S.
B3
B4
T65
Swan Creek
LEGEND
L22 LAKE SAMPLING STATIONS
B22 BEACH SAMPLING STATIONS
T55 TRIBUTARY SAMPLING STATIONS
Point Aux Peaux
B5
B6
Stony Pt.
Stony Creek
T70
BREST BAY
Woodland Beach
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
Detroit Beach
MICHIGAN
Sandy Creek
T75
STERLING STATE P
OHIO
MICHIGAN

B

LAKE ERIE
R
C
L11
L13
L14
L15
L17
L20
L24
L25
L26
L27
L28
B19
B20
B21
B22
B23
B24
B25
B26
B27
B28
B29
B30
B31
T80
T88
T95
T101
RLING STATE PARK
RAISIN RIVER
MONROE
Plum Creek
La Plaisance Creek
Bolles Harbor
Otter Creek
Toledo Beach
Luna Pier
Turtle Island

FIGURE 4

DETROIT RIVER–LAKE ERIE PROJECT

LOCATION OF SAMPLING STATIONS
MICHIGAN WATERS OF LAKE ERIE

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

25-B C

MIDDLE
RIVER
ROUGE RIVER
FORD ROAD
T26
OUTER DRIVE
ROUGE
RIVER
S. MILITARY ROAD
ROUGE
T25
LOWER
MICHIGAN AVE
DEARBORN
T24
T27
SOUTHFIELD ROAD
ROTUNDA DRIVE
T23
AREA LOCATION MAP
LAKE HURON
PORT HURON
MICHIGAN
LAKE ST CLAIR
DETROIT
WINDSOR
Rouge River
ONTARIO
LAKE ERIE
INTERNATIONAL BOUNDARY
CAN
U.S.
TOLEDO
SCALE IN MILES

A

MICHIGAN
T23
DRIVE
ROAD
ROTUNDA
GREENFIELD
T22
T21
ALLEN ROAD
SCHAEFER ROAD
T20
T19
FORT ST.
T18
OAKWOOD BLVD
WABASH RR
T17
T16
T15
AVE
T13
ZUG
RIVER ROUGE

B

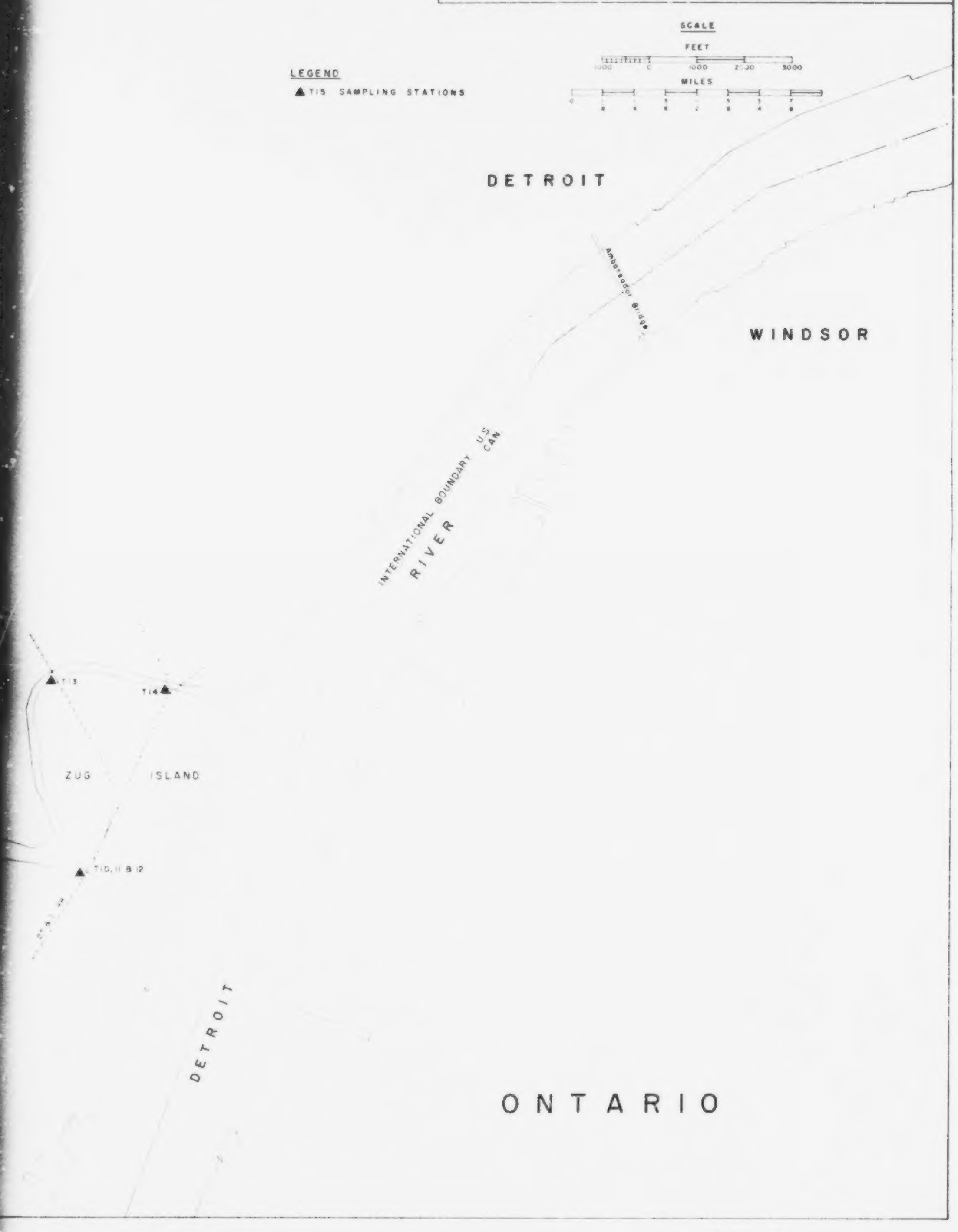
FIGURE 5

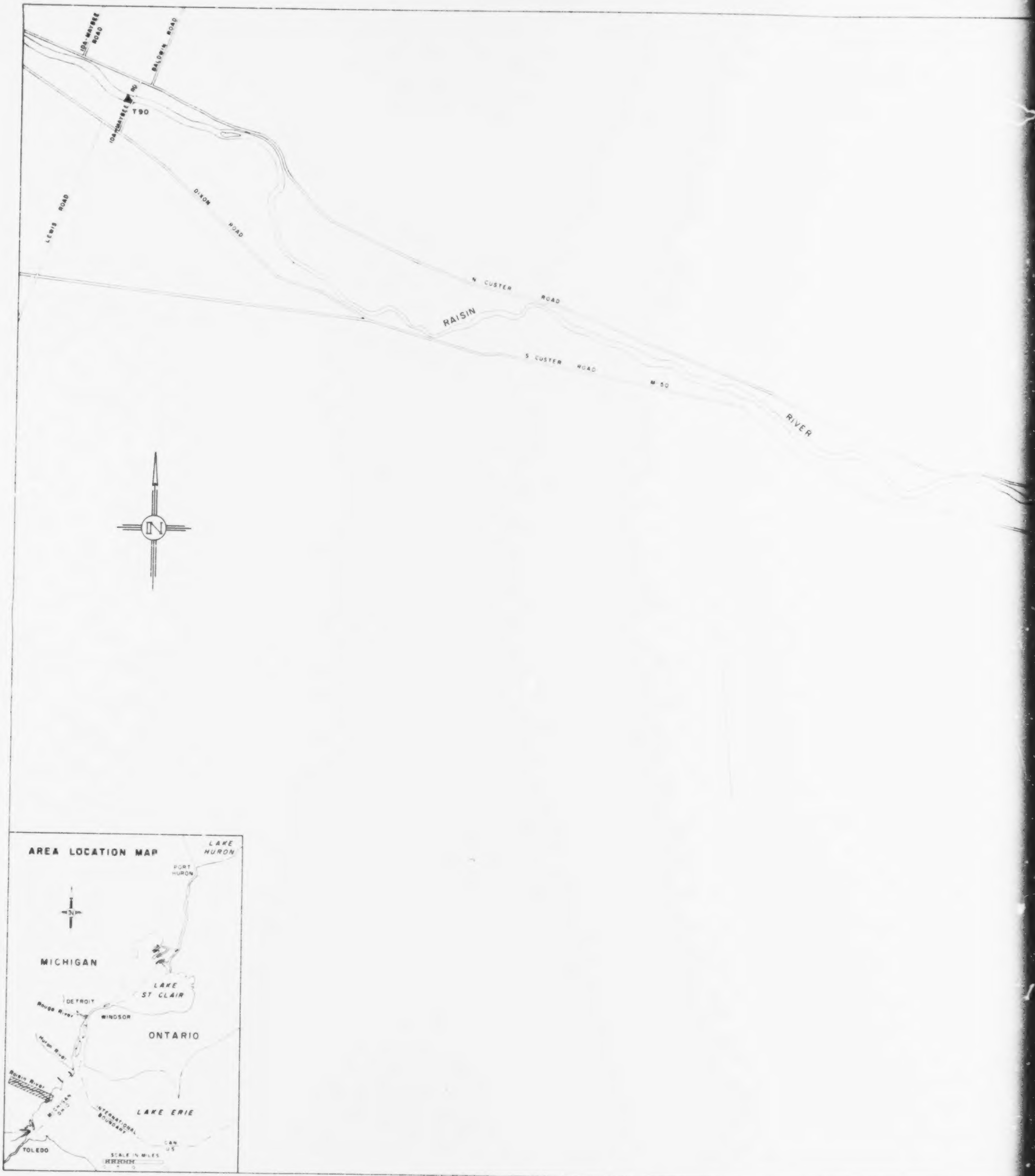
DETROIT RIVER—LAKE ERIE PROJECT

LOCATION OF SAMPLING STATIONS

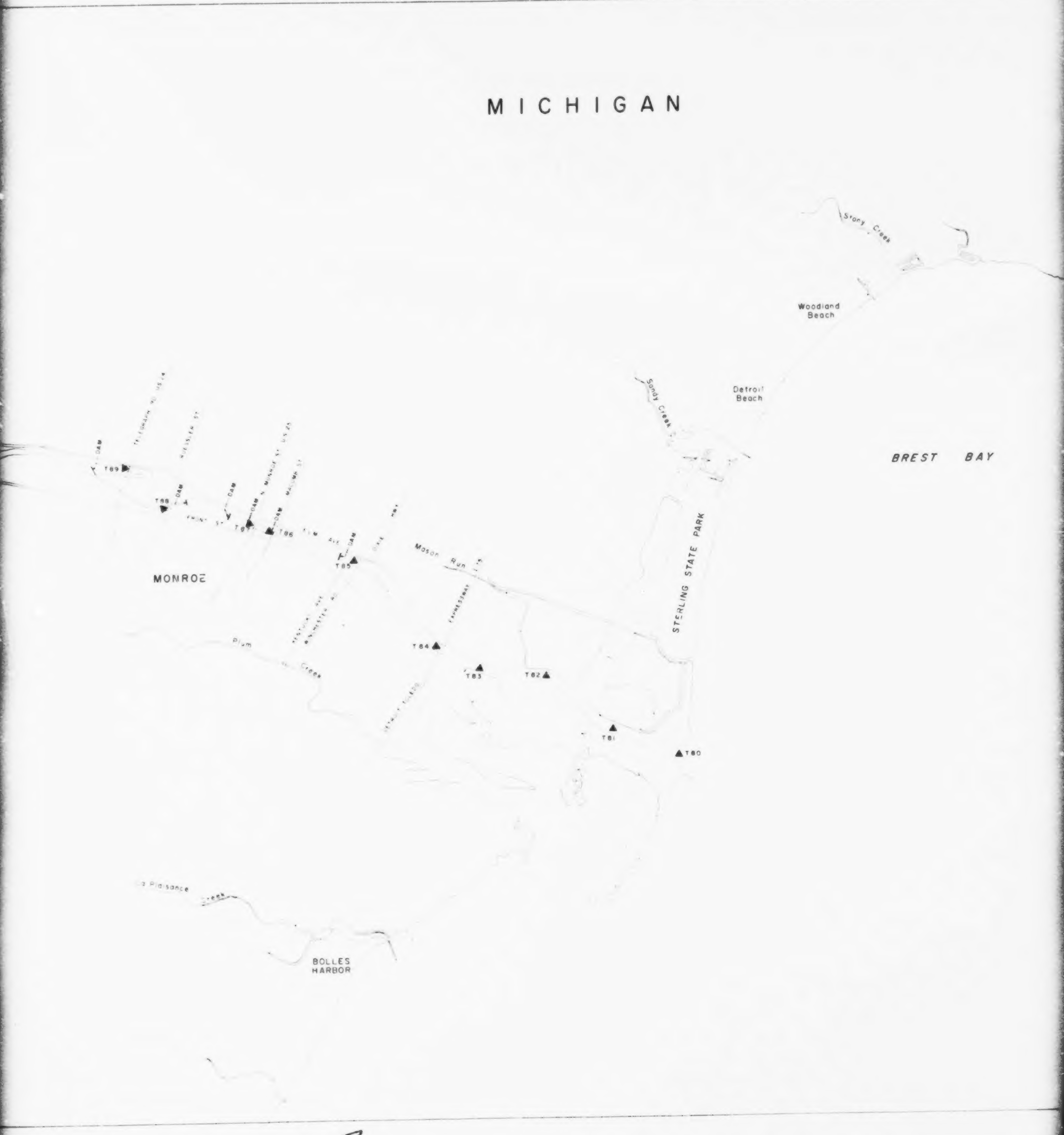
ROUGE RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



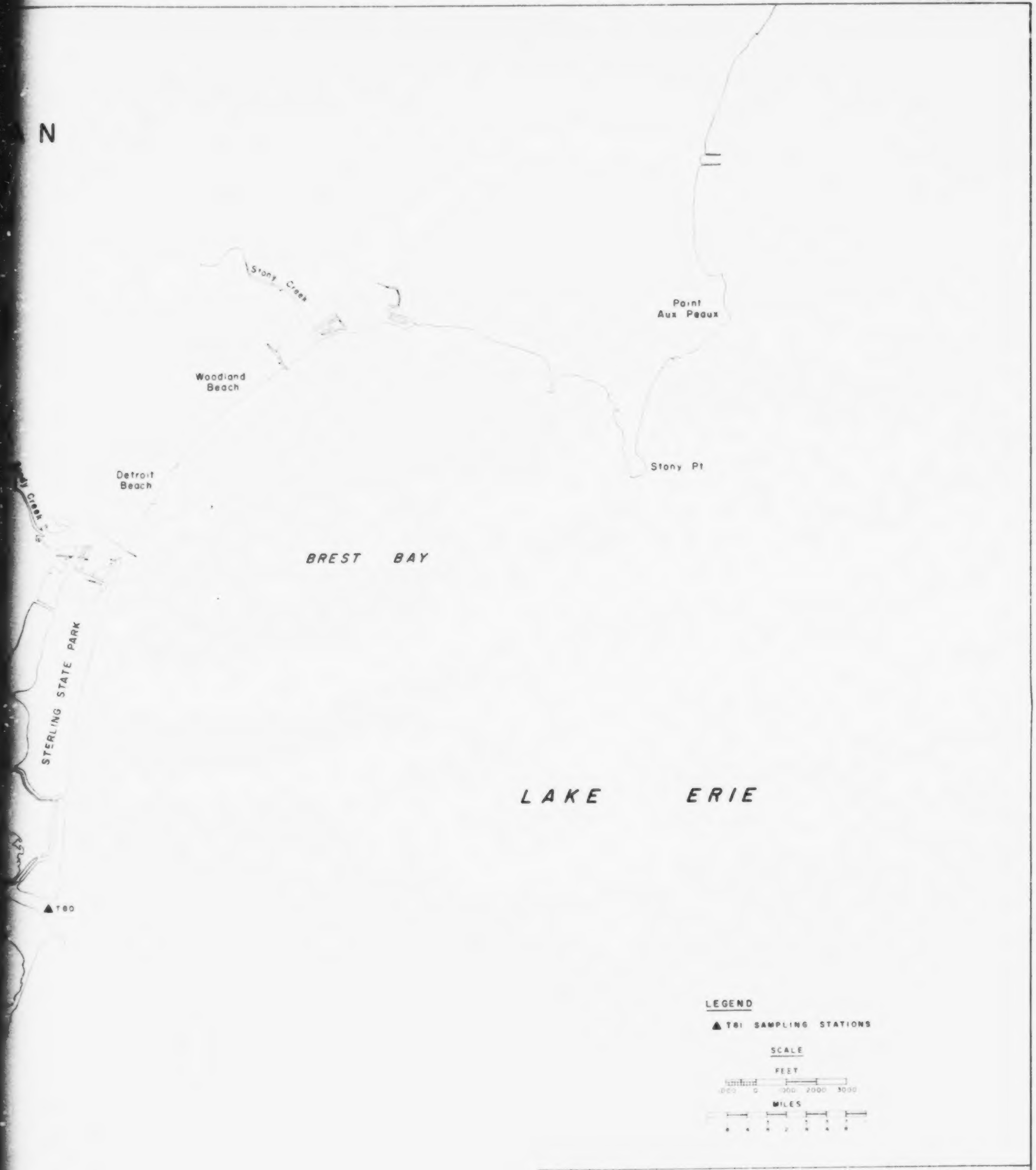

BALDWIN ROAD
LEWIS ROAD
DIXON ROAD
N CUSTER ROAD
RAISIN
S CUSTER ROAD
RIVER
AREA LOCATION MAP
LAKE HURON
PORT HURON
MICHIGAN
LAKE ST CLAIR
DETROIT
WINDSOR
ONTARIO
LAKE ERIE
INTERNATIONAL BOUNDARY
TOLEDO
SCALE IN MILES

A


MICHIGAN
Stony Creek
Woodland Beach
Detroit Beach
Sandy Creek
BREST BAY
STERLING STATE PARK
MONROE
Mason Run
Plum Creek
T89
T88
T87
T86
T85
T84
T83
T82
T81
T80
DAM
La Plaisance Creek
BOLLES HARBOR

B

FIGURE 6



DETROIT RIVER-LAKE ERIE PROJECT

LOCATION OF SAMPLING STATIONS

RAISIN RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

AREA LOCATION MAP
LAKE HURON
PORT HURON
MICHIGAN
LAKE ST CLAIR
DETROIT
Rouge River
WINDSOR
ONTARIO
LAKE ERIE
TOLEDO
SCALE IN MILES
MICHIGAN
DETROIT
WINDSOR
ONTARIO
LAKE ST CLAIR
BELLE ISLE
UNITED STATES RUBBER CO.
ANACONDA-AMERICAN BRASS COMPANY
REVERE COPPER AND BRASS INCORPORATED
FORD MOTOR CO ROUGE PLANT
SOLVAY PROCESS DIV ALLIED CHEMICAL CORP
PLASTIC DIVISION ALLIED CHEMICAL CORP
DARLING AND COMPANY
ROUGE
PEERLESS CEMENT CO
RIVER
SEMET-SOLVAY DIV ALLIED CHEMICAL CORP
GREAT LAKES STEEL CORP BLAST FURNACE DIVISION
AMERICAN AGRICULTURAL CHEMICAL COMPANY
SCOTT PAPER CO
GENERAL CHEMICAL DIV ALLIED CHEMICAL CORP
SOLVAY PROCESS DIV ALLIED CHEMICAL CORP
RIVER ROUGE
GREAT LAKES STEEL CORP HOT STRIP MILL
FUEL OIL CORP
DANA CORP
GREAT LAKES STEEL CORP ECORSE MILL
ECORSE
E.I. du PONT de NEMOURS & CO. INC INDUSTRIAL & BIOCHEMICALS DEPT
Ecorse River
Mud Island
Grassy Island
FIGHTING IS
WYANDOTTE CHEMICALS CORP NORTH SIDE WORKS

A

INDU
U.S.
ONTARIO
FIGHTING ISLAND
AMHERSTBURG
Bar Point
INTERNATIONAL BOUNDARY
ECORSE
GREAT LAKES STEEL CORP. ECORSE MILL
E.I. du PONT de NEMOURS & CO. INC. INDUSTRIAL & BIOCHEMICALS DEPT
Ecorse River
Pt. Hennepin
WYANDOTTE
WYANDOTTE CHEMICALS CORP. NORTH SIDE WORKS
WYANDOTTE CHEMICALS CORP. SOUTH SIDE WORKS
KOPPERS COMPANY
PENNSALT CHEMICALS CORPORATION
RIVERVIEW
FIRESTONE TIRE & RUBBER CO. FIRESTONE STEEL PRODUCTS DIV.
McLOUTH STEEL CORP. TRENTON PLANT
TRENTON
GROSSE ILE
MOBIL OIL CO.
CHRYSLER CORP. TRENTON ENGINE PLANT
MONSANTO CHEMICAL COMPANY
SHAWINIGAN RESINS CORPORATION
CHRYSLER CORP. CHEMICAL PRODUCTS DIVISION AMPLEX DIV.
McLOUTH STEEL CORP. GIBRALTAR PLANT
GROSSE ILE NAVAL AIR STATION
GIBRALTAR

FIGURE 7

DETROIT RIVER–LAKE ERIE PROJECT

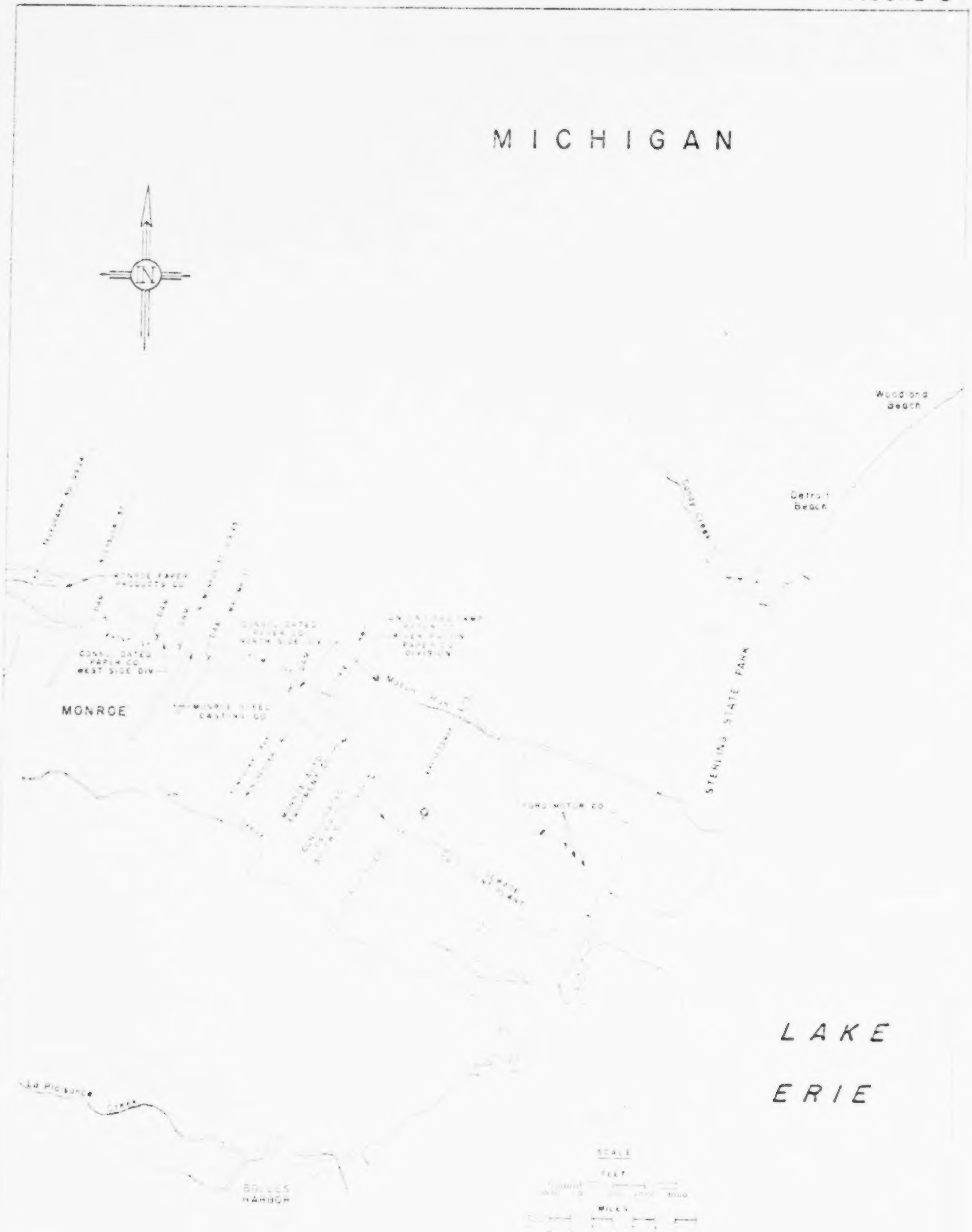
INDUSTRIAL WASTE OUTFALLS

U.S. WATERS
DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

25-E

FIGURE 8



LOCATION OF
INDUSTRIAL WASTE OUTFALLS
RAISIN RIVER

25-F

BOTTOM SEDIMENT SURVEY (SLUDGE SURVEY)

Purpose

Moving water has the capacity to carry particles of various sizes depending on the velocity of the water. As the moving water slows in areas where the river widens, or behind islands, the larger particles settle to the bottom. As the river water moves into the lake, the velocity is greatly reduced so that the finest settleable material will eventually find its way to the bottom of the lake. Some of these particles result from natural phenomenon, such as soil and bank erosion, and the debris from the life cycle of vegetables and animals. Other sediment results from man's activities and the purpose of this study is to identify such materials and determine their effect on water quality.

Method

One sample of bottom material was taken for every square mile in the Michigan portion of Lake Erie and at selected stations in the Detroit River where conditions were thought to be favorable for the settling of waterborne material.

When the boat arrived on a sampling station, a marker buoy with anchor attached was thrown overboard. Then the bottom sampler was launched overboard and allowed to sink to the bottom while the boat was drifting with the wind or current. Samples for DO were taken at the surface and at the bottom and a water-temperature profile measurement was taken. While this was being done, the sampler had been towed across the bottom by movement of the boat, and at the end of this operation the sampler was towed to the surface by means of a hand line. The contents were removed and observations made of color, consistency, odor, oil, and bottom fauna. The entire operation took place within a radius of one hundred feet of the anchor buoy marking the location of the

sampling point. At the end of the operation, the buoy was picked up and a timed run made to the next sampling point, where suitable points of observation were available. The exact location of the boat was verified by means of sextant shots.

After physical observations were made and recorded, the sample was placed in a one-half gallon glass jar. Part of the sample, well shaken and mixed, was then poured into a plastic jar containing H_2SO_4 preservative. This was later analyzed in the laboratory for the following: PO_4, NO_3, NO_2, N, NH_3, and phenols. The remaining part of the sample in one-half gallon jar was taken to the laboratory and analyzed immediately for pH, metals, and oils.

Location

The location of the sampling points are shown on the accompanying maps (Figures 9 and 10) and described on the list on page 28.

Equipment and Personnel

Crew - two or three
Boat - 25' or 31'
Detroit River-Lake Erie Project bottom sampler
Electronic thermometer
Kemmerer sampler
Sextant
Marker buoys

LOCATIONS OF DETROIT RIVER SLUDGE SAMPLING STATIONS

Station	Approx. Mile-Point	Description
S 1	5.3	West side NAS Channel, 1000' north of buoy R2. .
S 2	5.0	At buoy BC 3, south of NAS Channel.
S 3	5.0	At east set of piles off south tip of Horse Island.
S 4	5.0	800' east of last set of piles east off south tip Horse Island.
S 5	5.0	1450' east of last set of piles east off south tip Horse Island.
S 6	6.1	Trenton Channel at west shore on range extending from near weather bureau signal station to south tip Swan Is.
S 7	6.1	1100' from west shore (same range as S 6).
S 8	6.1	2800' from west shore (same range as S 6).
S 9	7.0	Trenton Channel 2000' west of East shore (Grosse Ile) at Groh Rd.
S 10	7.5	Trenton Channel 800' from west shore on range south of Monsanto Chemical Co. new dike.
S11	[illegible].5	1550' from west shore (same range as S 10).
S12	7.5	2400' from [illegible]st shore (same range as S 10).
S13	8.0	Trenton Channel off South end of Detroit Edison Co. coal dock.
S14	9.6	Tr[illegible]n Channel at west shore (end dock of O.C. Howey Boat Yard) on sampling range DT 9.6W.
S15	9.6	800' from west shore (same range as S14).
S16	9.6	1200' from west shore (same range as S14).
S17	10.5	Trenton Channel 100' from west shore on range opposite Church R. (Grosse Ile).
S18	10.5	800' from west shore (same range as S17).
S19	10.5	1200' from west shore (same range as S17).

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LOCATIONS OF DETROIT RIVER SLUDGE SAMPLING STATIONS

Station	Approx. Mile-Point	Description
S20	11.4	Trenton Channel at west shore on range in line with buoys BC 21 and RN 22.
S21	11.4	600' from west shore (at buoy BC 21)(same range as S20).
S22	11.4	1150' from west shore (same range as S20).
S23	12.2	Trenton Channel 100' from west shore on range from Firestone Steel Products Co. smokestack to Grosse Ile at a bearing of 110°.
S24	12.2	550' from west shore (same range as S23).
S25	12.2	950' from west shore (same range as S23).
S26	13.0	Trenton Channel at west shore on range extending from a point on the west shore 500' downstream from Wye Steet to Grosse Ile at a bearing of 120°.
S27	13.0	400' from west shore (same range as S26).
S28	13.0	800' from west shore (same range as S26).
S29	13.3	Trenton Channel at west shore off Wyandotte Chemicals Corp. (south plant) approximately 1300' upstream from Wye Street.
S30	13.8	Trenton Channel 50' from west shore on range extending through buoy R30 at a bearing of 110°.
S31	13.8	400' from west shore (same range as S30).
S32	13.8	800' from west shore (same range as S30).
S33	5.2	At buoy RN 2 approximately 1 mile south of Hickory Is.
S34	5.0	300' west of west edge of Livingstone Channel at south end of dike (approximately 1100' south of Lt. 13).
S35	5.0	200' east of east edge of Livingstone Channel at south end of dike (approximately 1000' south of Lt. 14).
S36	5.0	150' west of Lacey's Gas Dock near Bar Point, Canada.
S37	6.8	At buoy BC 13, 900' north of Sugar Is. east of Grosse Ile.

Station	Approx. Mile-Point	Description
S38	7.0	300' west of Livingstone Channel dike on line through Lt. 17 and Lt. 18 (Livingstone Channel).
S39	7.7	400' east of Grosse Ile and 1350' due west of buoy RN 6 (in area between Grosse Ile and Livingstone Channel).
S40	7.7	1400' east of Grosse Ile and 350' due west of buoy RN 6 (in area between Grosse Ile and Livingstone Channel).
S41	7.5	850' north of buoy HBC adjacent to Powder House Is. (in area between Grosse Ile and Livingstone Channel).
S42	7.5	400' northeast of south tip of easterly Livingstone Channel dike at the Sugar Is. cut (approximately 1100' north-northeast of Lt. 20 in Livingstone Channel).
S43	7.5	200' west of Canadian shore, 1450' north-northeast of buoy R 64 D in Amherstburg Channel.
S44	9.3	650' east of Grosse Ile on sampling range DT 9.3E (line from Ferry Rd. to Upper Entrance Light).
S45	9.3	800' west of buoy B 27 (same range as S44).
S46	9.3	At upper entrance light.
S47	9.3	750' east of upper entrance light (same range as S44).
S48	9.3	200' west of Canadian shore (same range as S44).
S49	14.6	100' from west shore on sampling range DT 14.6W (line from south pile at Wyandotte Power Plant to buoy R 92 in Fighting Is. Channel).
S50	14.6	850' from west shore (same range as S49).
S51	14.6	1600' from west shore at water intake (same range as S49).
S52	14.6	2250' from west shore at east end of cut (same range as S49).
S53	14.6	At buoy B 91 in Fighting Is. Channel (same range as S49).
S54	14.6	At buoy R 92 in Fighting Is. Channel (same range as S49).
S55	15.9	Fighting Is. Channel 200' southeast of Grassy Is. Light.

Station	Approx. Mile-Point	Description
S56	15.9	Fighting Island Channel 300' south of buoy R 96.
S57	15.9	Fighting Island Channel 650' east of buoy R 96.
S58	16.2	Junction Ecorse and Wyandotte Channels at west shore on range extending through buoys HB and R 18.
S59	16.2	At buoy HB (same range as S58).
S60	16.2	At buoy R 18 (same range as S58).
S61	17.1	Ecorse Channel at buoy BC 5..
S62	17.2	Head of Ecorse Channel at buoy B 7.
S63	17.1	Head of Ecorse Channel at buoy RN 6.
S64	17.0	Head of Wyandotte Channel at buoy BC 23.
S65	17.0	Head of Wyandotte Channel 150' south of buoy HB.
S66	17.0	Head of Fighting Island Channel 150' southeast of Fighting Island north light.
S67	17.0	Channel east of Fighting Island, 200' from Fighting Island on sampling range Dt 17.0E (line from Fighting Island at a bearing of 100° to Riverview Harbour Hoists in Canada).
S68	17.0	[illegible] from Canadian shore (same range as S67).
S69	18.4	At west shore on range extending from Great Lakes Steel Corp. (Ecorse plant) through the two buoys marking the south edge of the anchorage area.
S70	18.4	At buoy marking the southwest corner of the anchorage area (same range as S69).
S71	18.4	2700' from west shore and 500' from buoy marking southeast corner of anchorage area (same range as S69).
S72	18.5	In center of south Nicholson Slip 450' from mouth.
S73	18.6	In center of north Nicholson Slip 450' from mouth.
S74	19.0	At entrance to small boat dockage area along west shore 550' downstream from pipeline.

Station	Approx. Mile-Point	Description
S75	19.5	At entrance to small boat launching ramp along west shore approximately 700' upstream from north building line of Great Lakes Steel Corp. strip mill (first sampling point on range extending from the launching ramp at a bearing of 110° to the Canadian shore).
S76	19.5	1200' from west shore (same range as S75).
S77	19.5	2550' from west shore (same range as S75).
S78	19.7	100' from west shore opposite Detroit Edison Co. Rouge plant water intake.
S79		Rouge River (main channel) off south shore 800' downstream from West Jefferson Avenue bridge.
S80		Rouge River (main channel) off north shore 900' downstream from West Jefferson Avenue bridge.
S81		Rouge River (old channel) off east shore 400' southwest of DT&I RR bridge.
S82		Rouge River (old channel) off west shore 100' south of Scott Paper Co. conveyor.
S83		Rouge River (short-cut canal) off north shore 350' east of DT&I RR bridge.
S84		Rouge River (short-cut canal) off south shore 550' east of DT&I RR bridge.
S85	19.8	150' from west shore and 750' north-northeast of buoy R2 at mouth of Rouge River.
S86	20.0	50' from west shore on range extending from a point on Zug Island 1650' downstream from the north end of the Great Lakes Steel sheet piling to the north end of the Ontario-Hydro dock in Canada (bearing of range 110°).
S87	20.0	1350' from west shore on International Boundary (same range as S86).
S88	20.0	2600' from west shore at north end of Ontario-Hydro dock (same range as S86).
S89	20.3	100' from west shore 350' upstream from Allied Chemical Corp. piling.

Station	Approx. Mile-Point	Description
S90	21.2	At west shore on range extending from south edge of slip just south of Revere Copper and Brass to Confederation Coal and Coke Slip in Canada. (Bearing of range 110°.)
S91	21.2	950' from west shore (same range as S90).
S92	21.2	2000' from west shore and 75' from Canadian shore (same range as S90).
S93	22.1	At north shore on range 100' south and parallel to Ambassador Bridge.
S94	22.1	1000' from north shore on International Boundary (same range as S93).
S95	22.1	1550' from north shore and 150' from Canadian shore (same range as S93).
S96	24.5	At north shore on range extending from southwest corner car ferry slip warehouse to Canada at bearing of 170°.
S97	24.5	1250' from north shore at International Boundary (same range as S96).
S98	24.5	2500' from north shore at Canadian shore (same range as S96).
S99	25.7	At north [illegible] on range extending from Parke-Davis & Co. [illegible] Walker St. to northwest edge of Ford Motor Co. (Canada) building at bearing 155°.
S100	25.7	1550' from north shore (same range as S99).
S101	25.7	[illegible] from north shore at Canadian shore (same range as S99).
S102	28.4	50' from north shore on range extending from East edge Detroit Boat Basin slip to flagpole at end of Detroit Yacht Club dock.
S103	28.4	[illegible] from north shore and 50' from flagpole (same range as S102).
S104	29.4	At north shore 750' downstream from buoy [illegible].
S105	29.4	100' south of buoy [illegible].
S106	29.4	200' north of Lagoon Light on east end of Belle Isle.

Station	Approx. Mile-Point	Description
S107	28.2	Fleming Channel 100' from south shore Belle Isle on range extending from southeast edge of parking lot near flagpole (2800' upstream from Dossin Great Lakes Museum) to Canadian shore at bearing of 160°.
S108	28.2	Fleming Channel 1800' from south shore Belle Isle and 50' from Canadian shore (same range as S107).
S109	30.0	At north shore on range extending from mouth of Port Lagoon through buoys B5, HB, and R4 at bearing of 185°.
S110	30.0	950' from north shore at buoy B5 (same range as S109).
S111	30.0	2100' from north shore at buoy HB (same range as S109).
S112	30.0	3550' from north shore at buoy R4 (same range as S109).
S113	31.0	At east corner breakwater 1300' upstream from Windmill Point Light.
S114	31.2	At Rear Light (Peach Island Range Lights).
S115	30.8	50' from south shore Peach Island on range extending from Peach Island to Edgewater Thomas Inn (Canada) at bearing of 185°.
S116	30.8	950' from south shore Peach Island and 50' off Canadian shore (same range as S115).

LOCATIONS OF LAKE ERIE SLUDGE SAMPLING STATIONS

Shown below are the coordinates of all Lake Erie sludge sampling stations, expressed in miles North or South and East or West of the Detroit River Light.

4N - 1E
4N - 0
4N - 1W
4N - 2W

3N - 1E
3N - 0
3N - 1W
3N - 2W

2N - 1E
2N - 0
2N - ½W
2N - 1W

1N - 1E
1N - 0
1N - ½W
1N - 1W
1N - 1½W

0 - 1E
0 - 0
0 - 1W
0 - 2W

1S - 1E
1S - 0
1S - 1W
1S - 2W

2S - 2E
2S - 1E
2S - 0
2S - 1W
2S - 2W
2S - 3W
2S - 4W
2S - 5W

3S - 2E
3S - 1E
3S - 0
3S - 1W
3S - 2W
3S - 3W
3S - 4W
3S - 5W
3S - 5½W

4S - 1E
4S - 0
4S - 1W
4S - 2W
4S - 3W
4S - 4W
4S - 5W
4S - 5½W

5S - 0
5S - 1W
5S - 2W
5S - 3W
5S - 4W
5S - 5W
5S - 6W
5S - 7W
5S - 8W
5S - 9W

6S - 1W
6S - 2W
6S - 3W
6S - 4W
6S - 5W
6S - 6W
6S - 7W
6S - 8W
6S - 9W
6S - 9½W

7S - 2W
7S - 3W
7S - 4W
7S - 5W
7S - 6W
7S - 7W
7S - 8W
7S - 9W
7S - 9½W

8S - 3W
8S - 4W
8S - 5W
8S - 6W
8S - 7W
8S - 8W
8S - 9W
8S - 10W

9S - 4W
9S - 5W
9S - 6W
9S - 7W
9S - 8W
9S - 9W
9S - 10W

10S - 5W
10S - 6W
10S - 7W
10S - 8W
10S - 9W
10S - 10W
10S - 11W
10S - 12W

11S - 6W
11S - 7W
11S - 8W
11S - 9W

11S - 10W
11S - 11W
11S - 12W
11S - 13W

12S - 7W
12S - 8W
12S - 9W
12S - 10W
12S - 11W
12S - 12W
12S - 13W

13S - 8W
13S - 9W
13S - 10W
13S - 11W
13S - 12W
13S - 13W
13S - 14W

14S - 11W
14S - 12W
14S - 13W
14S - 14W
14S - 15W

15S - 10W
15S - 11W
15S - 12W
15S - 13W
15S - 14W
15S - 14½W

16S - 11W
16S - 12W
16S - 13W
16S - 14W
16S - 14½W

17S - 13W
17S - 14W

9 3/8S - 7 7/8W (Raisin River Dumping Ground)

LOCATIONS OF RAISIN RIVER SLUDGE SAMPLING STATIONS

Station	Description
SRA - 1	Midway between buoys BC9 and RN10 in the Raisin River Channel.
SRA - 2	Midway between buoys BC11 and RN12 at the mouth of the Raisin River.
SRA - 3	Mid-channel in the Raisin River east of the turning basin near buoy BC15.
SRA - 4	Mid-channel in the Raisin River under the Interstate 75 bridge.

LOCATION OF
BOTTOM MATERIAL STATIONS
DETROIT RIVER

FIGURE 10

LOCATION OF
BOTTOM MATERIAL STATIONS
LAKE ERIE

Detroit River-Lake Erie Project — Special Studies

Sludge Study Data Sheet

Crew: W. Hartranft, R. Hartranft, S. Hendricks, P. Harris

Date: 8-30-63 Boat: 31' Sextant No. 31165 Recorder Harris

Location: Lake Erie 3S-2W Time: 0930

Sextant Sights	Perm. Powerplant Water Tower	18-40	Range Light	100-03	Detroit R. Light

Bottom Description:

A. Particle size (circle one or more)
- (ooze) — circled
- clay, silt, mud
- (sand) 1/25" — circled
- (gravel) 1/25"-¼" — circled
- pebbles ¼"-2"
- stones 2"-10"

B. Color: Dark Brown

C. Odor: Oily

D. Visual evidence of oil: Yes

E. Bottom fauna: Few Sludgeworms

F. Depth of Sludge Layer:

G. Other Comments: Depth 23'

Meterological Data:
- Air Temp (°C) 22.0
- Wind (dir. & vel.) WSW-4 MPH
- Waves (dir. & ht.) WSW ½'
- Barometer 30.28
- Gen. Description FAIR

Temperature Profile

Depth (ft.)	°C
0	21.0
4	
8	
12	
16	
20	
24	
28	
32	
36	
40	

D.O. Samples
- Taken
- Not taken ✓
- Bottles Nos.
- 5' depth
- bottom

Detroit River-Lake Erie Project — Special Studies

Sludge Study Data Sheet

Crew: W. Hartranft, H. Henkes, A. Paintz

Date: 9-6-63 Boat: 51' Sextant No. 31478 Recorder Paintz

Location: Lake Erie 13S-14W Time: 1350

Sextant Sights	Toledo Harbor Light	35-35	Turtle Island Tower	65-48	Consumer's Power Plant Stacks

Bottom Description:

A. Particle size (circle one or more)
- ooze
- clay, silt, mud
- (sand) 1/25" — circled
- gravel 1/25"-¼"
- pebbles ¼"-2"
- stones 2"-10"

B. Color: Gray-Brown

C. Odor: None Apparent

D. Visual evidence of oil: No

E. Bottom fauna: Few Sludgeworms

F. Depth of Sludge Layer:

G. Other Comments: Depth 7'

Meterological Data:
- Air Temp (°C) 23.5
- Wind (dir. & vel.) ESE-7 MPH
- Waves (dir. & ht.) ESE 1'
- Barometer 30.32
- Gen. Description: FAIR

Temperature Profile

Depth (ft.)	°C
0	22.0

D.O. Samples:
- Taken
- Not Taken ✓
- 5' depth
- bottom

METHODOLOGY

CURRENT TRACING TECHNIQUE (FLUOROMETRIC)

Purpose

The majority of fluorometric current tracing operations in the Detroit River fall into three general categories. First, are those studies performed to determine flow patterns in an area of changing channel characteristics such as at the head of an island or channel division. Second, are dye releases made within or at the outfalls of sewage treatment plants in the area. Six of these studies were made in the Detroit River area, three from the City of Detroit sewage treatment plant outfall, and one each from sewage outfalls on Belle Isle, in Trenton, and in Wyandotte. The third major area of study is at the mouth of the Detroit River where current patterns in the transition zone from river to lake were desired.

Methods

A typical current tracing operation begins by anchoring the boat at a dye release point and pumping Rhodamine B dye slowly into the water. A position fix is taken and the time of release and other pertinent information is recorded. Floats are placed at the head and at the tail of the dye streak as the dye is pumped. As long as the dye can be seen, it is traced visually by making timed runs into the dye from a temporary buoy left at the release point, and by cross-referencing the location of the dye streak with respect to prominent landmarks or buoys. Characteristics of the dye streak are noted such as its length and width, and any irregularities in shape.

Cross-sectional runs across the dye plume using the fluorometer begin as the dye becomes visually faint. This operation requires a minimum of four

men; two sextant operators, one fluorometer operator and recorder, and one boat operator. The boat is aimed at a buoy or at a prominent landmark on the opposite shore, or set on a compass course. A speed is selected between ten and twenty feet per second. Approximately one minute before the run is to commence, the pump and fluorometer are turned on to permit electronic components to warm up, and air bubbles to be expelled from the system. As the run is started, the recorder on the fluorometer is switched on and a reference mark is made on the chart. Sextant fixes follow at approximately one-minute intervals (closer if the cross-section is short). The fluorometer operator marks the chart each time a fix is taken, records the time of the fix to the nearest five seconds, and logs the angles as read by the sextant operators. Occasionally fixes are not used during a dye cross-section, usually in an area containing numerous buoys. In this case, a course between several buoys is run and reference marks are made on the recorder chart at each buoy. It is particularly important that speed remain as uniform as possible between buoys when using this method.

Sufficient sextant fixes are plotted in the field to check for errors. Upon completion of a day's work, the recorder chart is removed from the machine and properly labelled. Due to the construction of the recorder, which will not permit a pencil to be inserted near the stylus, and also a 30-second time lag in the tubing and intake apparatus, the position fix marks on the chart lag the corresponding points on the curve of dye concentration by three-quarters of an inch (chart speed is 30 inches per hour). Thus, all fix marks must be shifted this distance and properly identified shortly after the runs have been made. If all field records are clear and complete, the final plotting and interpretation of results can be postponed to a later time.

DYE STUDIES PERFORMED IN THE DETROIT RIVER
(upstream to downstream)

Map #	Date	Description of Release Point
1	9/23/63	Upper Peach Island Range Light
2	9/24/63	North of piling above Windmill Pointe Light
3	10/7/63	5 visual traces done at head of Belle Isle
4	7/30/63	Belle Isle sewage treatment plant (outfall line)
5	5/16/63	Buoy "HB" south of Belle Isle
6	5/13/63	Range Dt 20.6 (approximate center of channel)
7	5/14/63	Range Dt 20.6 (300' east of International Boundary)
8	5/15/63	Range Dt 20.6 (300' from west shore)
9	6/20/63	In Rouge River (old channel) near mouth
10	6/20/63	In Rouge River (main channel) at Dix Avenue bridge
11	5/8/63	Detroit sewage treatment plant (over outfall)
12	[illegible]/17/63	Detroit sewage treatment plant (outfall line)
13	[illegible]/18/63	Detroit sewage treatment plant (outfall line)
14	10/7/63	3 visual traces at head of Fighting Island
15	10/7/63	7 visual traces at beginning of Fighting Island, Wyandotte, and Ecorse Channels
16	10/7/63	1 visual trace above Point Hennepin
17	6/24-25/63	Wyandotte sewage treatment plant (outfall line)
18	5/1/63	Grosse Ile county bridge (middle of swing span)
19	5/2/63	Grosse Ile county bridge (approximate mid-channel)
20	6/26/63	Trenton sewage treatment plant (outfall line)
21	5/7/63	Middle Livingstone Channel at Upper Entrance Light
22	5/9/63	Livingstone Channel cut
23	7/9/63	Range Dt 3.9 (approximate 5000' from west shore)

Map #	Date	Description of Release Point
24	6/6/63	Range Dt 3.9 (approximate 5000' from west shore)
25	6/6/63	Range Dt 3.9 at middle of Livingstone Channel

DYE STUDIES PERFORMED IN LAKE ERIE
(other than synoptic vector work)

Map # *	Date	Description of Release Point
1	6/10/63	3 visual traces in Raisin River-Brest Bay
2	6/11/63	4 visual traces in Raisin River-Brest Bay
3	6/27/63	1 visual trace at buoy B1 (west outer channel)
4	7/9/63	Off Pointe Mouillee
5	7/16-17/63	Off Pointe Mouillee
6	8/6-7/63	Buoy B1 (west outer channel)
7	8/7/63	1000' south of Stony Point

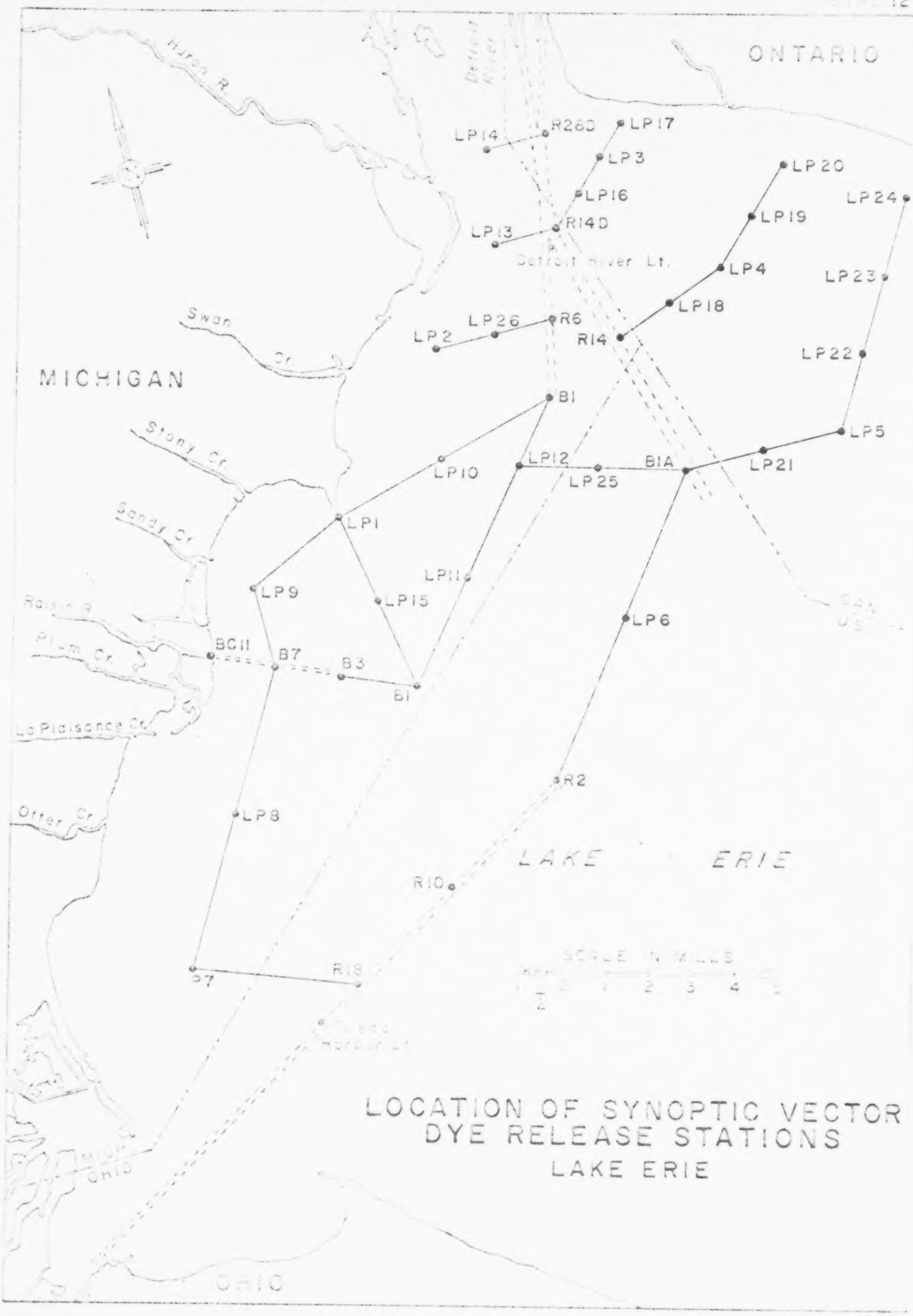
*See Figure 13

FIGURE 11

LOCATION OF
DYE RELEASE STATIONS
DETROIT RIVER

41-A

FIGURE 12

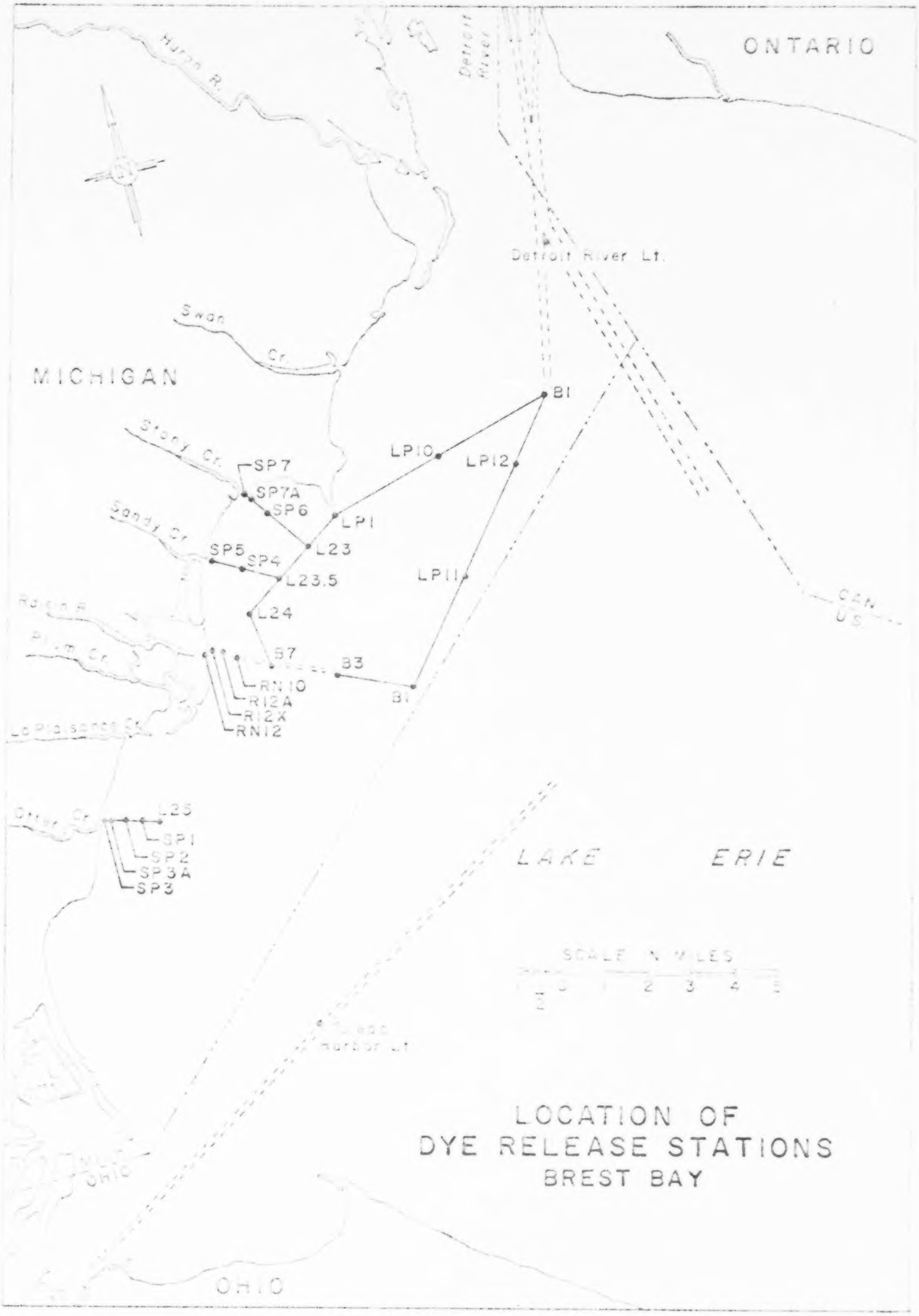


LOCATION OF SYNOPTIC VECTOR
DYE RELEASE STATIONS
LAKE ERIE

FIGURE 13

LOCATION OF
DYE RELEASE STATIONS
LAKE ERIE

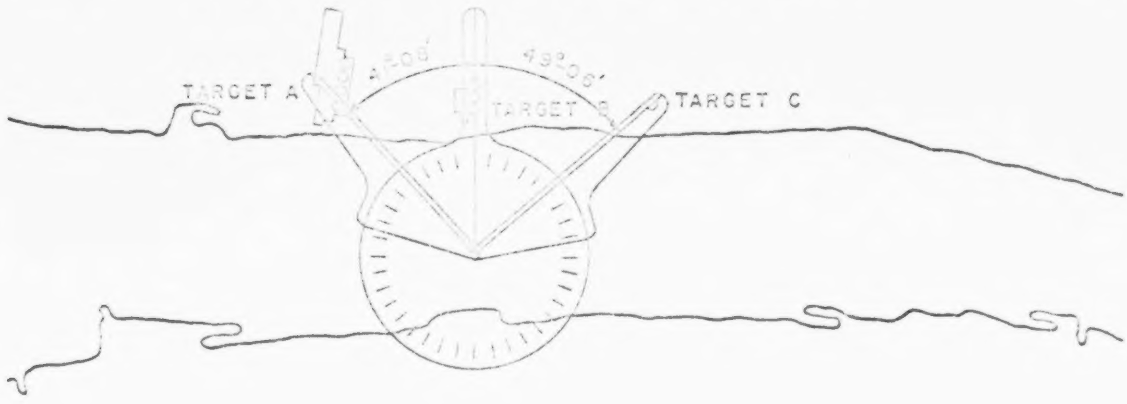
41 c



LOCATION OF
DYE RELEASE STATIONS
BREST BAY

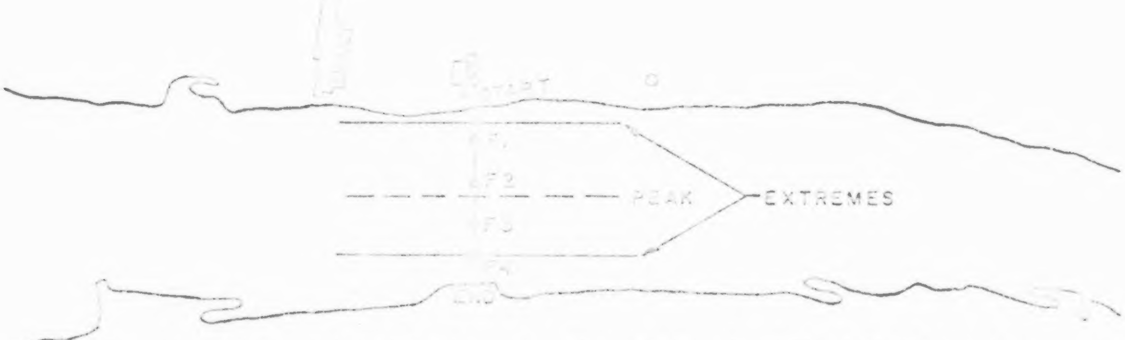
FIGURE 14

METHOD OF PLOTTING RESULTS FLUOROMETRIC DYE STUDIES



PLOTTING A SEXTANT POSITION FIX ON A RANGE
USING A 3-ARM PROTRACTOR

A PORTION OF FLUOROMETER RECORDER CHART
SHOWING DYE LOCATION AND CONCENTRATION
ACROSS THE RANGE



ADDING DYE LOCATION DATA TO PLOT OF RANGE

[illegible]: DRLEP		SPECIAL Studies			31' BOAT	
[illegible]: FLUOROMETRIC Dye Run - Belle Isle Area					[illegible]	
[illegible]: W. HARTRANFT, R. Bunn, P. Harris, L. O'Leary					[illegible] 3147 F	
					[illegible] 3116 S	
Date: 23 Sept 1963	[illegible]: P. HARRIS		[illegible]: L. O'L.		Page 1 of 2 Pages	

[illegible]	Time min.sec	[illegible]	Position Data (Descriptive or Fix) Target A	Angle AB	Target B	Angle BC	Target C
RP1	1210	dye release began	Approx.	50' E. of Peach I. Range LTS			
	1217	" " ended		(FRONT LT.)			
OBS 1	1247	run 82 sec. @ 2000 RPM	@ 295°	= 3300' from RP			
OBS 2	1312	run 284 sec @ 1000 RPM	@ 290°	= 2800' from Rear LT			
		(just below line from Windmill PT To RN 10)					
Range 1	1320-45	begin 25' from Light	W. End Bulkhead		Peach I. Front LT.		Peach I. Rear Lt.
	21-05		"	21-33	"	28-20	"
	21-20		"	29-36	"	26-45	"
	22-30		"	39-40	"	23-13	"
	23-00		"	43-01	"	21-14	"
	23-40		"	46-16	"	19-42	"
	24-05		"	48-39	"	17-07	"
	24-35	at buoy RN 10 - end run	"	50-58	"	15-03	"
Range 2	1335-20	at buoy B7	Windmill PT. LT.		Peach I. Front Lt.		Peach I. Rear Lt.
	35-35		"	13-24	"	12-27	"
	36-10		"	15-46	"	12-10	"
	37-[illegible]		"	17-14	"	12-04	"
	37-[illegible]		"	20-59	"	11-58	"
	37-55		"	23-44	"	11-56	"
	38-10		"	25-48	"	11-47	"
	38-45		"	25-40	"	11-47	"
	39-20		"	33-48	"	11-47	"
	40-10	at buoy RN [illegible] end run					
Range 3	1348-15	at buoy [illegible]	[illegible] Dev. Lt.		Windmill PT. LT.		Peach I. Rear LT.
	48-[illegible]			124-23	"	25-40	"
	49-[illegible]			111-35	"	25-59	"
	49-55			106-00	"	26-31	"
	50-[illegible]	at Peach I. Lt.		91-57	"	27-02	"
	51-[illegible]			91-57	"	27-48	"
	52-[illegible]			83-54	"	28-17	"
Range 4	1401-00	at buoy R4	2000 RPM	CONSTANT	SPEED		
R1	02-20	at buoy [illegible]					
	03-10	at buoy [illegible]					
Range 4	1405-45	at buoy RN 4	2000 RPM	CONSTANT	SPEED		
R2	06-[illegible]	at buoy [illegible]					
	07-[illegible]	at buoy [illegible]					
Range 5	1416-30	at buoy RN 2	1000 RPM	CONSTANT	SPEED		

41 F

CURRENT TRACING TECHNIQUE (SYNOPTIC VECTOR CRUISE)

Purpose

The synoptic vector cruise is this Project's method of obtaining current pattern information for one set of meteorological conditions over a large area (i.e. the Michigan waters of Lake Erie), in a relatively short period of time. A technique such as this is necessary when currents are relatively slow, as in a lake, and the study period must be short. Fluorometric techniques would be much too time-consuming to be used by the Detroit River-Lake Erie Project.

Method

The method is as follows. A number of dye release locations were selected initially to give as complete coverage as possible for the area in question (i.e. Michigan waters of Lake Erie). One, or occasionally two boats visit all release points designated for the day's work in an order determined primarily by convenience. If the point happened to be a navigation buoy, a small quantity of concentrated Rhodamine B dye was poured next to it and the time of release recorded. Most release points were not marked, however, and exist only as a bearing and a distance from some reference point (buoy, shore, etc.). To locate them a timed run was [illegible] from the proper reference point and, upon arrival, a temporary buoy was released to mark the spot. Dye was then released in the same manner as with an existing buoy. While waiting for the dye to move away from the release point, wind direction and velocity readings were taken and a temperature profile recorded. A timed run was then made from the buoy to the center of the dye plume. Three items were recorded following this run:

dye direction, time elapsed from buoy to dye, and the time the run ended. Conversion of the "time elapsed from buoy to dye" reading to distance from buoy to dye was simplified by maintaining a constant boat speed during runs at ten feet per second.

Plotting the results obtained at a release point can often be done during the fifteen minute waiting period at the next point. A small field work map, drawn especially for this work, was used. To complete the field record dye vector direction, dye rate of travel (in fpm), time of dye release, and wind direction and velocity were entered on the field map next to the vector drawn from the release point.

Analysis of results was approached in two ways. The first method involved scanning individual synoptic vector cruises for daily current pattern trends. This would give successful results under conditions of constant winds and water level during the period of field measurement. In the other method, results for each station were tabulated and broken down into groups by wind direction and velocity. Results from all stations for a particular set of wind conditions were then plotted and analyzed for an overall current pattern for a given wind situation.

Location

The location of all synoptic vector dye release points is shown on Figure 12 and are described on the list shown on pages 45 and 46.

Equipment and Personnel

Crew - two (2) per boat
Boat - 31' and/or 25'
Dye release apparatus
Stopwatch
Marker buoy
Dye in quart polyethylene bottles
Electronic thermometer or regular thermometer
Charts and forms

SYNOPTIC VECTOR CRUISE DYE RELEASE STATIONS (LAKE ERIE)

Station	Description
R 28D	Buoy on east edge of channel near Light 29D
R 14D	Buoy on east edge of channel near the Detroit River Light
R 14(EOC)	Buoy on east edge of East Outer Channel
B1A (EOC)	Extreme southerly buoy on west edge of East Outer Channel
R 6(WOC)	Buoy on east edge at West Outer Channel
B1 (WOC)	Extreme southerly buoy on west edge of West Outer Channel
B1 (RRC)	Extreme easterly buoy on south edge of Raisin River Channel
B3 (RRC)	Buoy on south edge of Raisin River
B7 (RRC)	Buoy on south edge of Raisin River Channel
BC11 (RRC)	South buoy at mouth of Raisin River
R 2(THC)	Extreme easterly buoy on north edge of Toledo Harbor Channel
R 10(THC)	Buoy on north edge of Toledo Harbor Channel
R 18(THC)	Buoy on north edge of Toledo Harbor Channel
LP 1	1000' south of tip of Stony Point
LP 2	15000' at a bearing of 270° from R6(WOC)
LP 3	10000' at a bearing of 45° from buoy R14 (EOC)
LP 4	15000' at a bearing of 70° from buoy R14 (EOC)
LP 5	20000' at a bearing of 90° from buoy B1A (EOC)
LP 6	20000' at a bearing of 215° from buoy B1A (EOC)
LP 7	20000' at a bearing of 290° from buoy R 18 (THC)
LP 8	20000' at a bearing of 30° from station LP 7
LP 9	10000' at a bearing of 180° from buoy B7 (RRC)
LP 10	11500' at a bearing of 75° from station LP 1

Station	Description
LP 11	15000' at a bearing of 40° from buoy B1 (RRC)
LP 12	15000' at a bearing of 40° from station LP 11
LP 13	7500' at a bearing of 270° from buoy R 14D
LP 14	7500' at a bearing of 270° from buoy R 28D
LP 15	11500' at a bearing of 170° from station LP 1
LP 16	5000' at a bearing of 45° from buoy R 14D
LP 17	5000' at a bearing of 45° from station LP3
LP 18	7500' at a bearing at 70° from buoy R 14 (EOC)
LP 19	7500' at a bearing of 45° from station LP 4
LP 20	7500' at a bearing of 45° from station LP 19
LP 21	10000' at a bearing of 90° from buoy B1A (EOC)
LP 22	10000' at a bearing of 30° from station LP 5
LP 23	10000' at a bearing of 30° from station LP 22
LP 24	10000' at a bearing of 30° from station LP 23
LP 25	10000' at a bearing of 105° from station LP 12
LP 26	7500' at a bearing of 270° from buoy R 6 (WOC)

I

Office: DRLEP	Field Operations Section		
Subject: Synoptic Vector Cruise			Angle Sextant #
Crew: W. Hartranft, R. Hartranft, P. Harris			Left / Right
Date: 8-7-63	Recorded by: P. Harris	Checked by: L. O'W.	Page 1 of 2 pages

Release pt. - Dye	Time	Direction of Dye Travel	Dist. Dye Traveled (ft.)	Elapsed Time (Min.)	Rate of Dye Travel (ft./min)	Wind Dir. & Vel. (mph)	Remarks, etc.
R14(EOC)	0924	195°	350	18	20	Calm	
	0941						
LP4	0954	190°	150	15	10	Calm	
	1009						
R18(EOC)	1022	205°	200	13	15	Calm	
	1035						
LP5	1047	280°	100	15	7	W5	
	1102						
LP6	1123	235°	250	17	15	WSW5	
	1140						
R2(THC)	1154	320°		15	10	SW6	
	1209						
R10(THC)	1214	290°-330°		18	3	SSW3	Stream 100' wide ⊥ to
	1232						dir. from buoy
R18(THC)	1241	Results are inconclusive				Calm	
	1252						
LP7	1305	10°	250	15	17	Calm	
	1[illegible]						
LP8	1333	0°	200	[illegible]	13	SSW9	
	1348						
LP11	1432	30°	250	[illegible]	19	SSE12	
	1445						
LP12	1455	45°	250	14	18	S10	
	1509						
R14D	1531	165°	500	12	14	S12	
	154[illegible]						

#46 A

FLOW MEASUREMENTS IN THE DETROIT RIVER

Purpose

Flow measurements were made on each sampling range in the Detroit River. The purpose of this is to determine the "percent of flow" distribution for this Project's sampling points across a range, rather than for the amount of flow. Actual flow in cfs was taken from the weekly averages published by U.S. Lake Survey. The laboratory analysis of samples yields a concentration value for each substance tested. To get the total quantity of these materials passing a range in some unit of time, it is necessary to know the amount of flow that should be assigned to each sample. The flow measurements made by this Project were used to determine the percent of total river flow that each sampling point represents.

Method

Because the Detroit River averages approximately 3,000 feet wide and is from 20 to 40 feet deep, a different method of velocity measurement was required than that used on tributaries. The boat was put in approximate position on the sampling range by a timed run, then anchored in place and accurately located by a sextant position fix. The water depth at the gaging site was measured using the depth-indicating cable reels on one of the modified bridge cranes mounted at the stern of the boat. One current meter was lowered to two-tenths depth and the other to eight-tenths depth. The number of meter revolutions in four minutes was used instead of the one-minute interval that was used on the tributaries, to allow for possible variations in velocity caused by turbulence or surges in the river channel. Both meters were read

simultaneously. The boat pulled anchor and the operation proceeded to the next gaging point. From ten to fifteen gaging points were used per sampling range. The same computational methods were used for determining flow at each point as were used on the tributaries. River cross-sections were drawn and velocity curves constructed. From these velocity curves, the flow at each sampling point was determined.

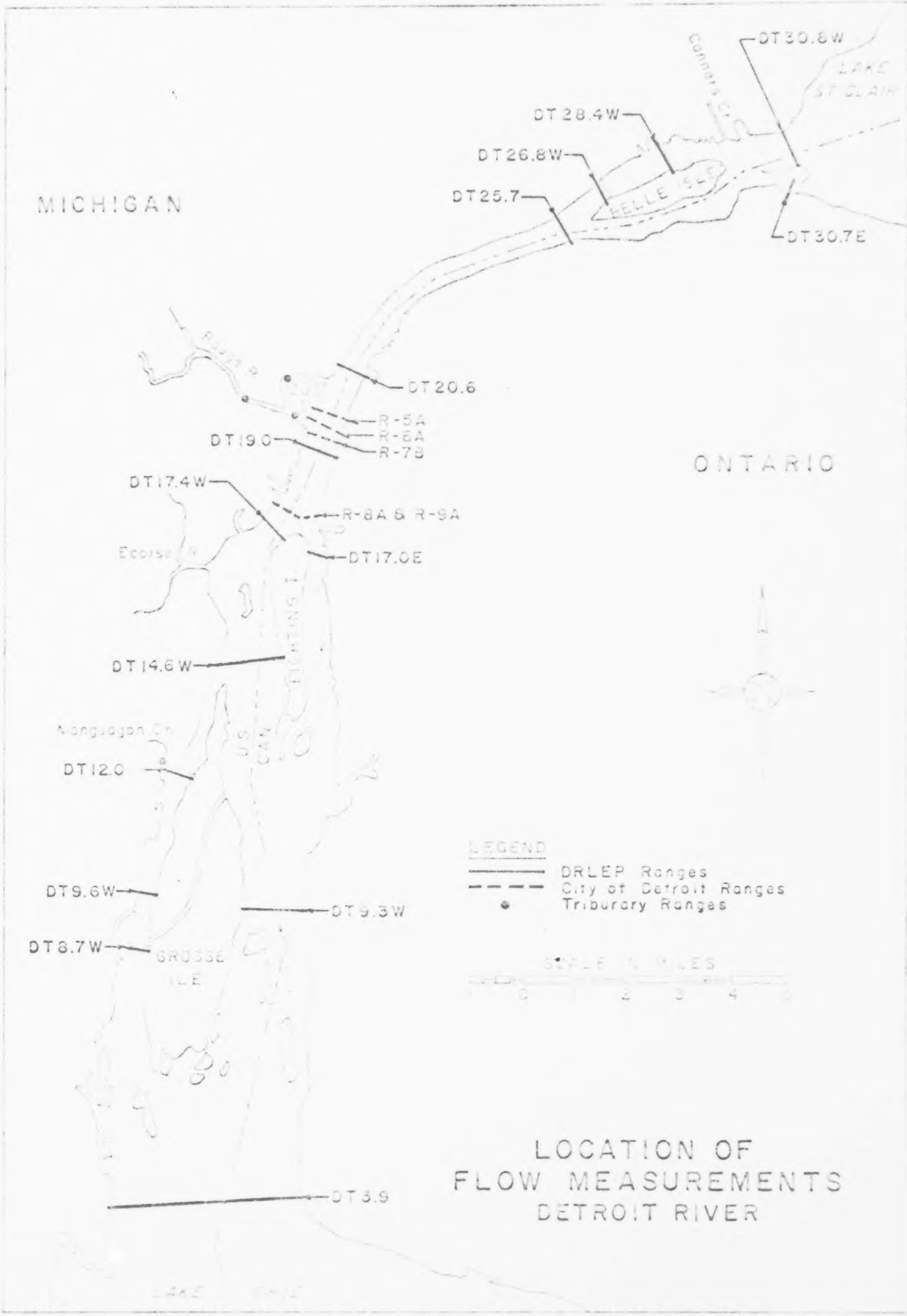
Location

The location of Detroit River sampling ranges is shown on Figure 15.

Equipment

Crew - three (3)
Boat - 31'
Cranes - two (2)
2 Price Type A current meters
2 Stopwatches
2 Sextants
Charts and forms
3-Arm protractor

FIGURE 15



LOCATION OF FLOW MEASUREMENTS DETROIT RIVER

TRIBUTARY STREAM GAGING

Purpose

Stream flow was measured on each tributary sampled so that a relationship could be established to determine the quantity of water flowing each time a water quality sample was taken. The laboratory results indicate the concentration of each substance in the sample. These concentration values are then applied to the quantity of water flowing at the time to give the total pounds of material carried by the stream, per unit time.

Method

On each tributary, a gaging site was selected to measure flow. A staff gage was installed and each time the tributary was sampled, the gage reading was recorded. By comparing this reading with the rating curve drawn for the particular site, the flow in cfs was determined for each sample taken. The site selected for the measuring section in each case, was above the backwater effects of Lake Erie or the Detroit River. The staff gages were installed where optimum metering conditions and good hydraulic control were found.

A Price Type A current meter was used in most cases for measuring flow, but in shallow areas and in low flow during the summer the pigmy Price meter was used. With the larger Price meter, measurements were taken at .2 depth and .8 depth when the depth of the river exceeded 1.5 feet. When the depth was less than 1 foot, the pigmy meter was used at the .6 depth. The number of sections taken across the stream varied from 10 to 20 depending on the width of the stream. At each measuring point, the velocity of the current was determined by counting the number of revolutions per minute on the current meter and reading the velocity from a table furnished with the instrument. The cross-section area for that reading was then multiplied by the flow to

give the total cfs for that measurement. The total for all the measurements across the river was added together to give the total flow for the river at that time. By making several of these measurements at gage readings, a rating curve was developed from which the flow could be determined by reading the gage during the sampling operations.

Location

The location of the tributary gaging sites is shown on the accompanying chart (Figure 16) and are described on page 51.

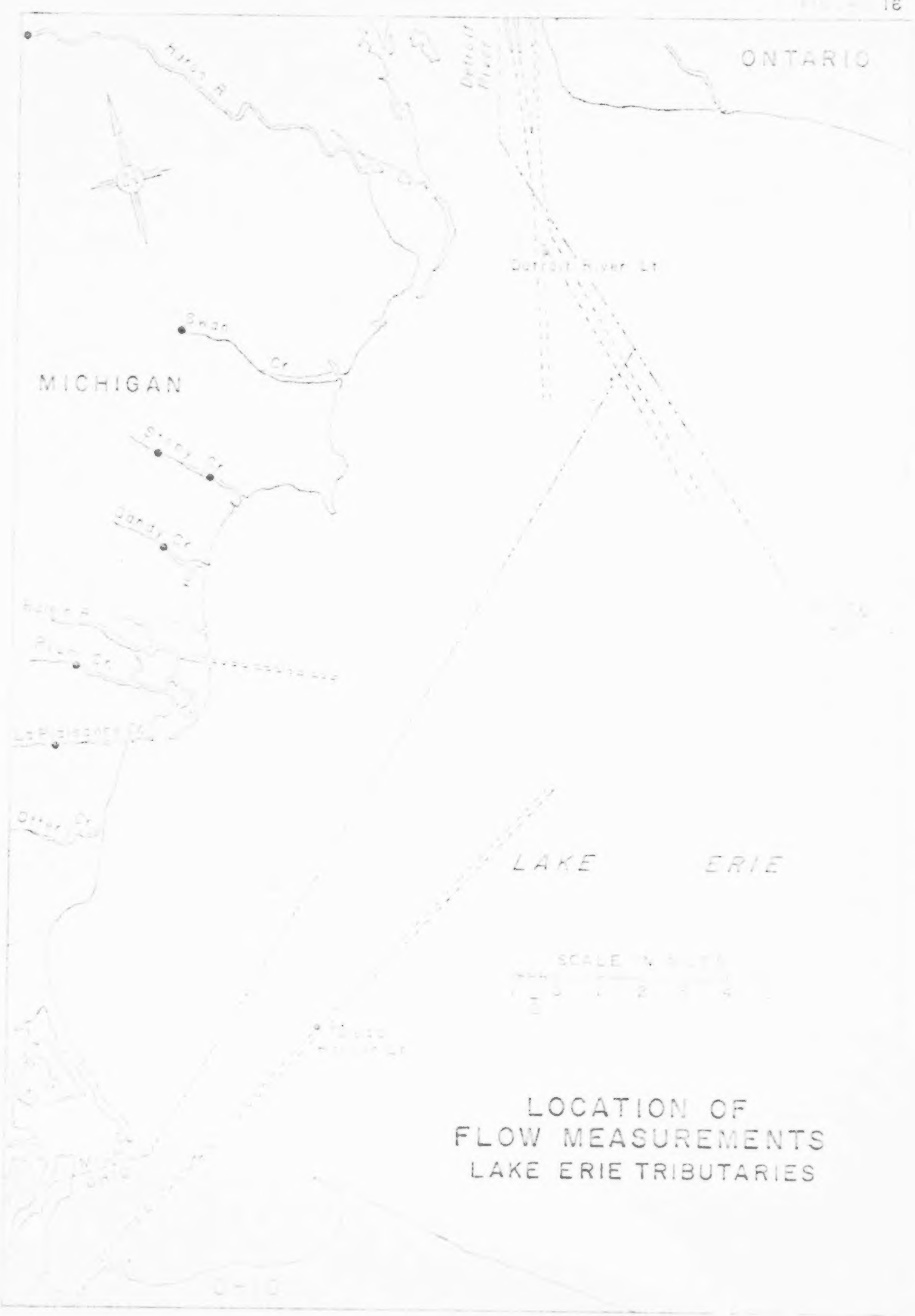
Equipment

The following is a list of equipment required for stream gaging:

- Staff gage
- Level
- 100-foot tape
- Stopwatch
- Current meter
- Tagline

LOCATIONS OF FLOW MEASURING SECTIONS ON TRIBUTARIES
TO THE
DETROIT RIVER AND LAKE ERIE

Tributary	Section Location
Ecorse River (North Branch)	Southfield Road bridge in Ecorse
Ecorse River (South Branch)	Emmons Blvd. bridge in Lincoln Park
Monguagon Creek	Jefferson (Biddle) Ave. bridge in Riverview
Huron River	Willow Road bridge (500' upstream) west of Flat Rock
Swan Creek	Drew Road bridge in Newport
Stony Creek	Detroit & Toledo Shore Line RR bridge (adjacent to North Stony Creek Road) in Frenchtown
Sandy Creek	North Dixie Hwy. bridge near Detroit Beach
Plum Creek	New York Central RR bridge (adjacent to Kentucky Ave.) in Monroe
LaPlaisance Creek	Detroit & Toledo Shore Line RR bridge (adjacent to Albain Rd.) south of Monroe



LOCATION OF
FLOW MEASUREMENTS
LAKE ERIE TRIBUTARIES

EQUIPMENT

To conduct the sampling program, many types of equipment were utilized. The equipment available plays a part in determining the speed and efficiency of sampling operations. Some of the equipment used by the Project is described here in order to give a clearer picture of sampling work done.

Boats

31-foot Bertram

The 31-foot Bertram is the Project's largest boat. This fiberglass hull is approximately 31 feet in length with an 11-foot beam and a 2½-foot draft. Because of its sturdy design and twin [illegible] hp engines, it proved to be a safe, fast, and seaworthy boat for open water. It is large enough to carry specialized survey equipment and a crew of [illegible] to 5 men.

25-foot Bertram

The 25-foot Bertam has basically the same fiberglass hull construction as the 31-footer. It was mainly used for river sampling because of its 10-foot beam and large open-work area. A secondary use was for industrial waste outfall sampling since the stern-mounted outboard units allowed the operator to place the bow in shallow areas.

1[illegible]-foot Turbocraft

A fast runabout with a 220 hp engine, the Turbocraft jet-powered boat has no propeller and can operate in shallow waters. It was used to sample industrial waste outfalls and do other shallow water work.

14-foot Aluminum Utility

The 14-foot Baco Craft Aluminum Utility with a 10 hp outboard motor was used as a cartop boat for sampling in tributaries and in protected areas of the Detroit River.

9-foot Pram

Powered by a 3 hp outboard motor, the 9-foot aluminum pram was a lightweight cartop boat used for sampling along beaches, in coves, on tributaries, and in areas which the other boats could not maneuver.

Collection Devices

Scoop Sampler

This collection device shown in Figure 17 was constructed by the Project personnel. It was used in regular sampling to collect most of the surface samples. Both chemical and bacteriological bottles fit snugly into their respective holders and can be inserted or withdrawn quickly making it possible to take several samples per minute with this device.

Bridge Sampler

The bridge sampler is essentially a scoop sampler with the pole removed and a line in its place.

Industrial Waste Sampler

A device, designed and constructed by the Project, consists of a polyethylene container on an aluminum handle which may be used as a scoop dipped into an outfall at various angles.

Kemmerer

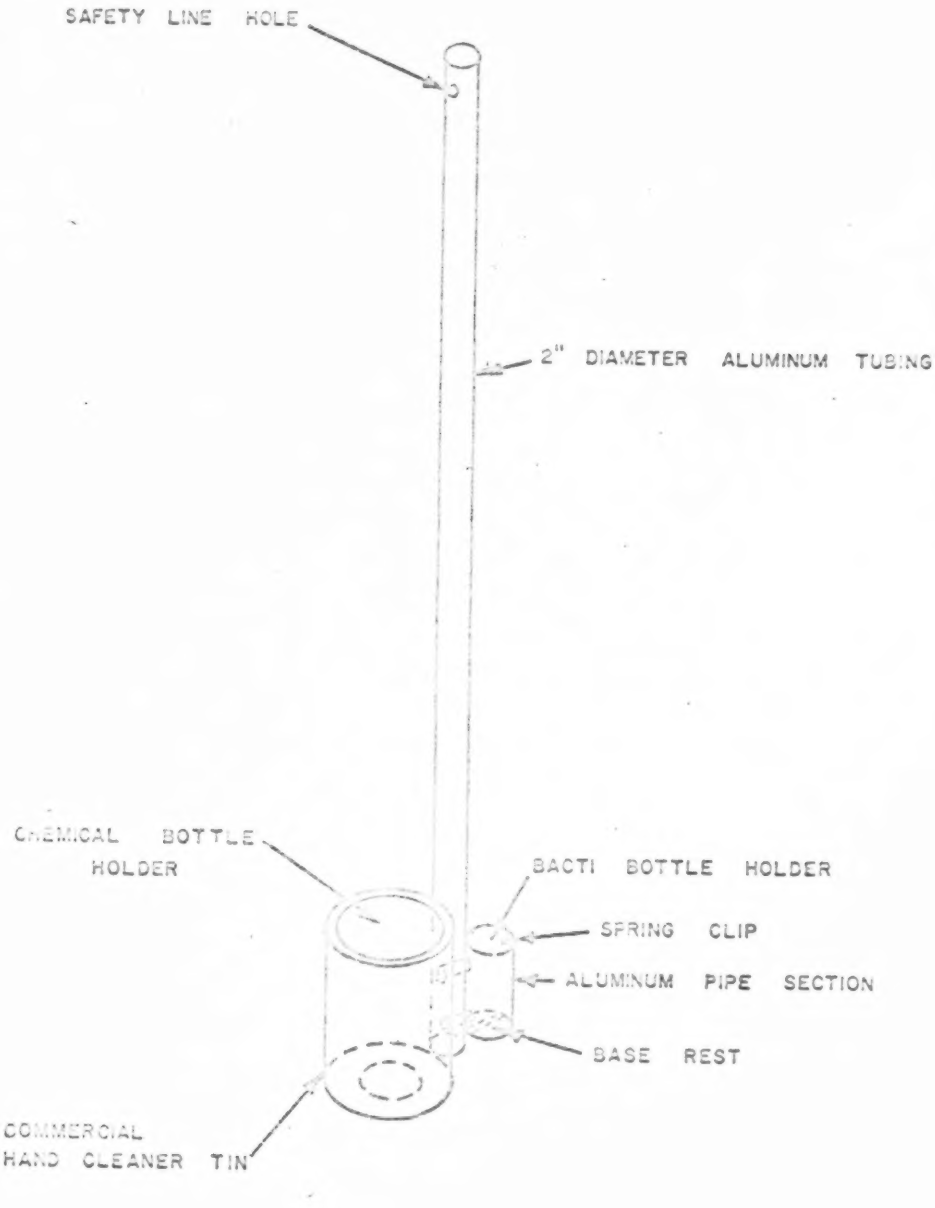
For collecting chemical samples at various depths, a Kemmerer sampler was used. This device which is shown in Figure 18 can collect an 18-inch column of water (3,000 cubic centimeters in volume) at any depth desired by entrapping it between the 2 valves or stoppers.

A.P.H.A. Sewage Sampler

Figure 19 illustrates the construction of the American Public Health Association Sewage Sampler. Used mainly for collecting dissolved oxygen samples at any depth, it is designed to eliminate the possibility of entrapping air in the water during collection.

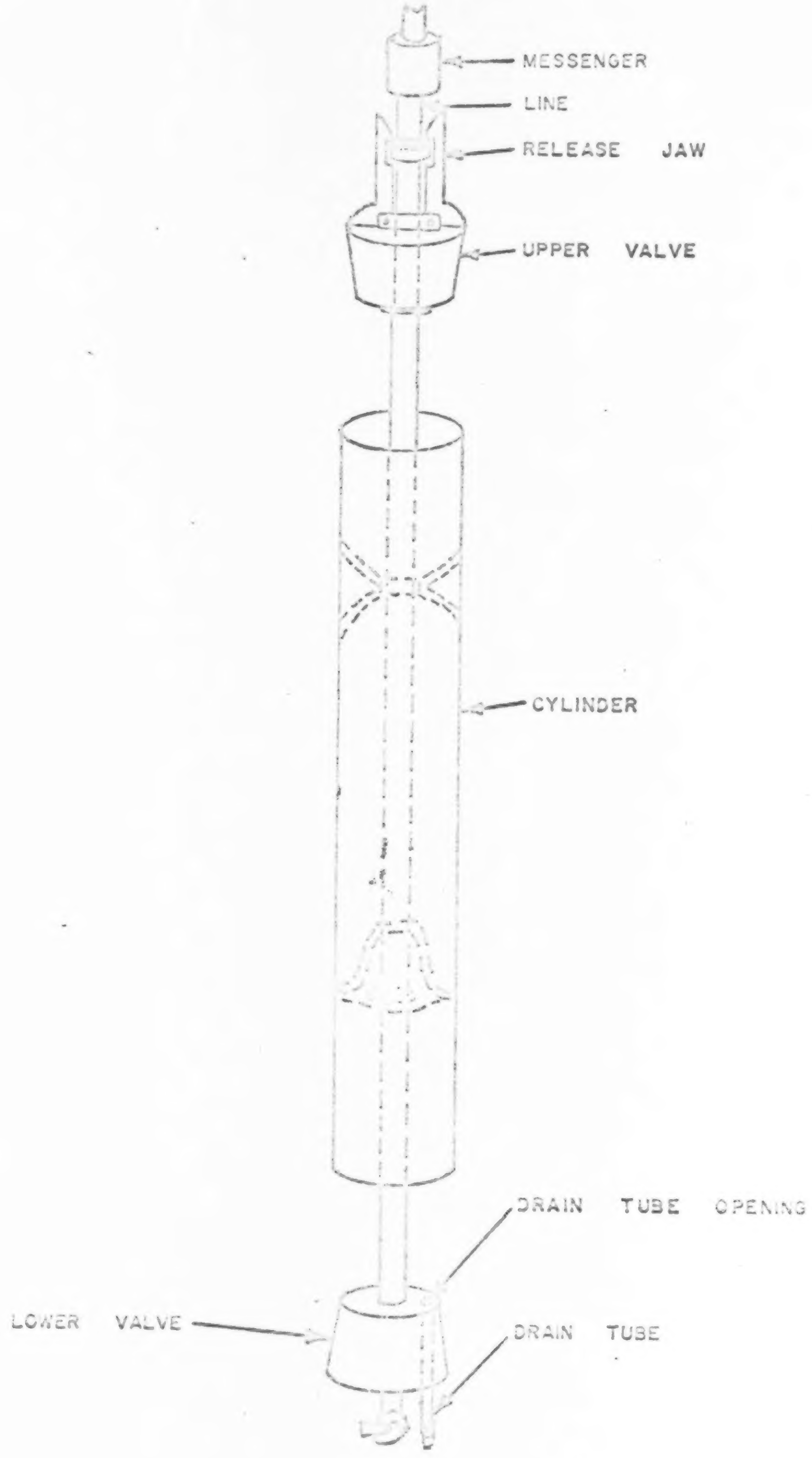
J.Z. Aseptic Bacteriological Sampler

The J.Z. Bacteriological Sampler is a mechanical device designed to aseptically sample water at any depth in a lake or ocean. Since this is a relatively new type of collection device, a description of its use is in order. Figure 20 shows the assembled instrument ready for use. It is provided with a glass reagent bottle, 250 ml capacity for the shallow water use as was required by this Project. All components, except the messenger, must be sterilized before use and assembled under aseptic conditions. The glass

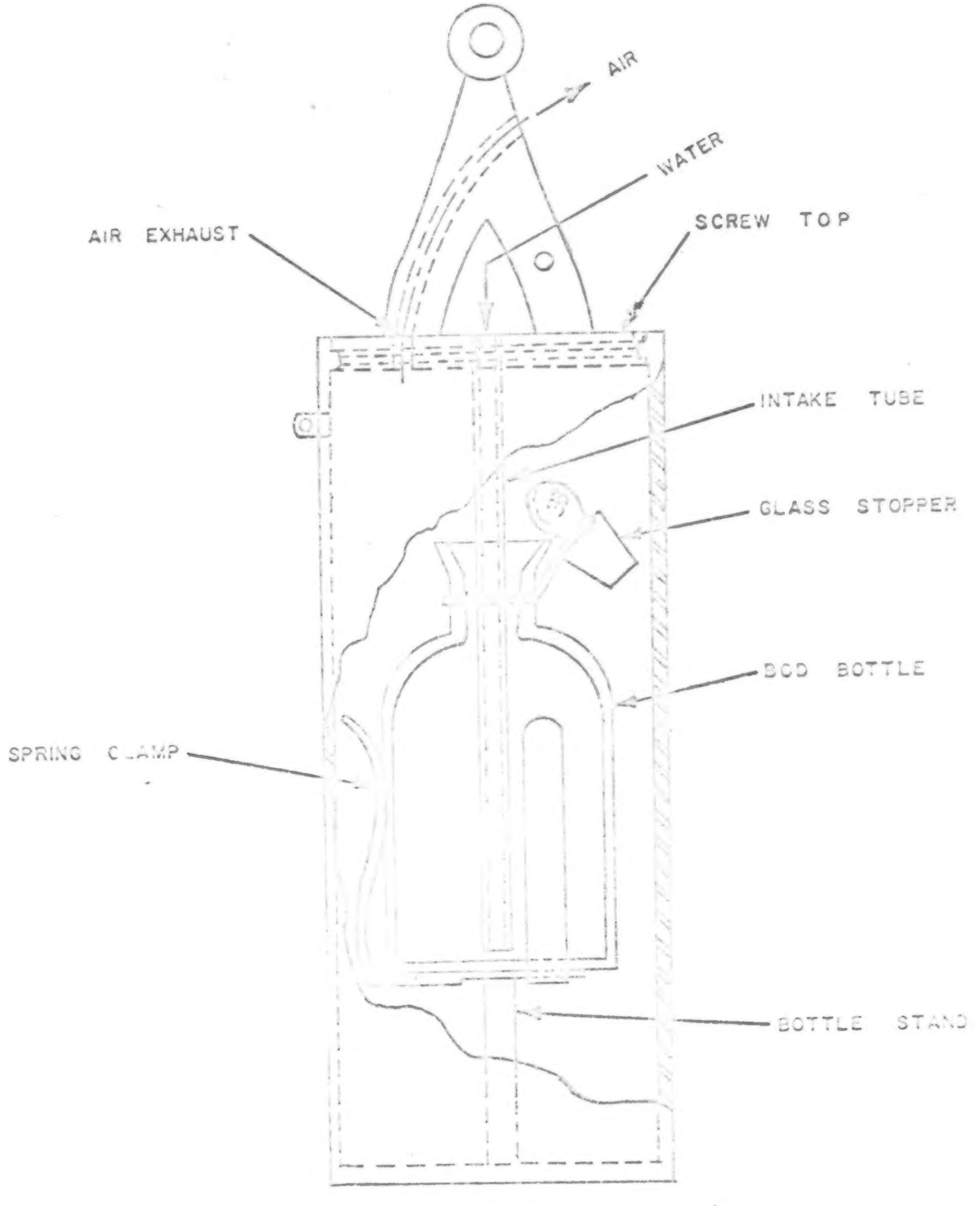


SCOOP SAMPLER

FIGURE 18

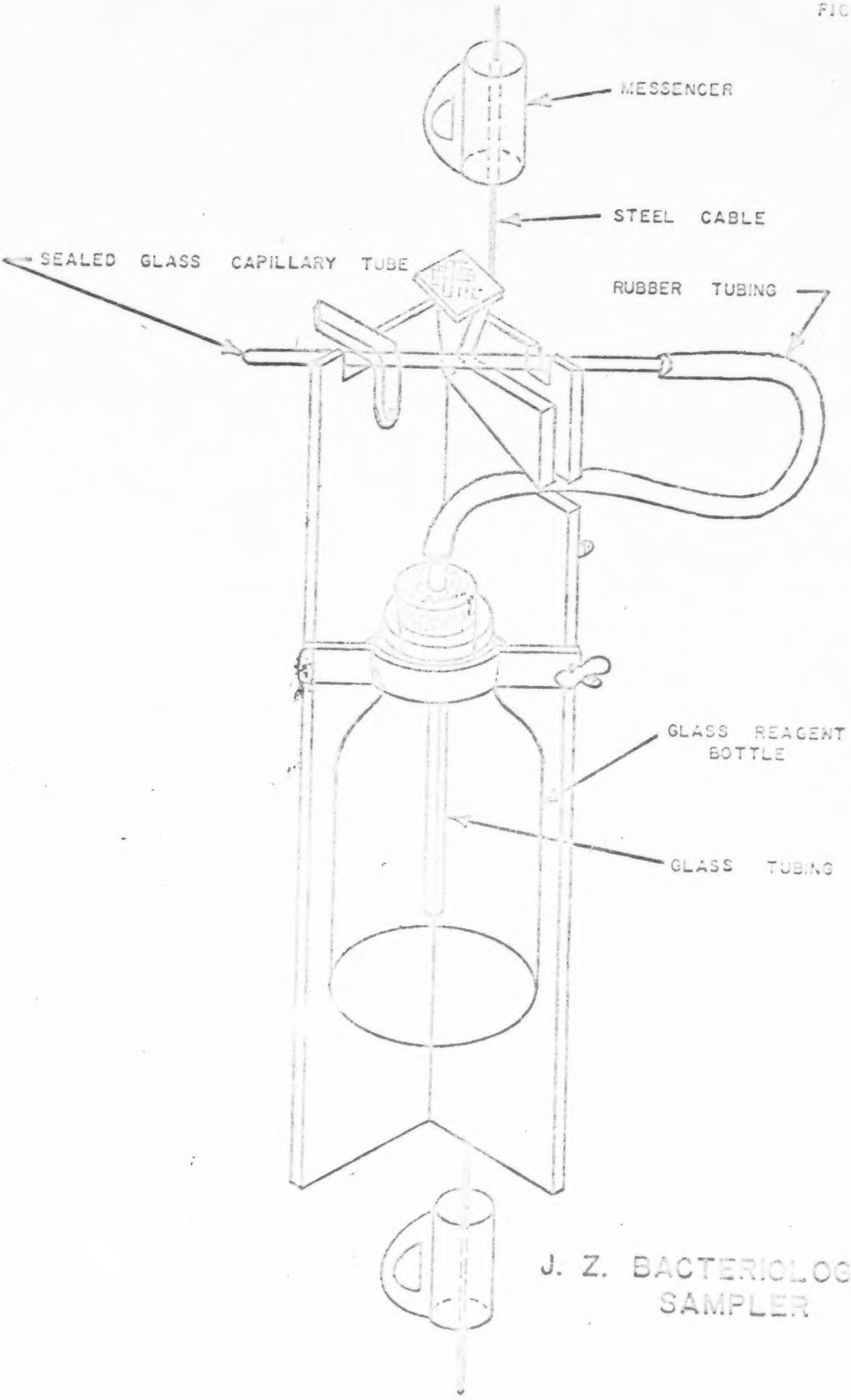


KEMMERER SAMPLER



APHA SEWAGE SAMPLER

FIGURE 20



J. Z. BACTERIOLOGICAL
SAMPLER

54.0

bottle and its glass and rubber tubing should be assembled while hot to create a partial vacuum upon cooling. The sampling operation is quite simple. After the frame is attached to the wire and lowered to a desired depth, a messenger is released from above. This messenger strikes a tripping lever which is forced upward against the sealed capillary glass tube and breaks it. The broken tube attached to the flexible rubber tubing flips over sideways so that the open end of the glass tube is approximately 6 inches away from the metal frame. The evacuated bottle immediately aspirates water and is filled in a matter of minutes. J.Z. Samplers may be attached in series to a ship's wire for multiple sampling at a single station.

Bottles

Chemical

For field transportation of chemical samples, the Project has been using wide-mouth, half-gallon glass jars with black plastic screw-caps. These can be purchased from any of the leading chemical supply houses at about 50 cents per bottle.

Bacteriological

The bacteriological bottles used were of the wide-mouth round, reagent type with a 250 ml capacity. Stoppers for these were etched metric glass, covered with heavy gage aluminum foil to protect the mouth from contamination before use.

Navigation and Plotting Instruments

Sextant

The sextant is a portable instrument for measuring the angle between two objects and is well suited to navigation work on small boats as it does not require stable support. The instrument operates on the principal of optically aligning the reflected image of one object with a second object. This is accomplished by moving a pivoted arm containing a mirror, in an arc until coincidence between the two objects occurs. The angle between the two is then read directly from a graduated scale on the arc around which the pivoted arm is swung. Although the instrument is equipped with a telescope, it is rarely used when sights are fairly close, thus allowing greater speed in making observations.

To take position fixes from a moving boat, two sextants are employed. Three targets (objects) are used with the middle target common to both left and right hand sextant shots. On signal, both shots are taken simultaneously. As long as the boat is not located on a circle passing through the three sextant stations, position of the boat can be determined from the two angles so obtained.

When the boat is at anchor, and therefore, time is not a factor, one sextant and one operator may take both sights.

Three-arm Protractor

The three-arm protractor is an instrument used to obtain a graphical solution from position fix data. This device consists of a disk with three arms projecting from its center. The middle arm is fixed and is at the zero degree location of two graduated scales marked at degree intervals in clock-wise and counter-clockwise directions about the circle. The movable arms of the

protractor are set at their respective sextant shot angles and are clamped by means of a thumb screw. The type of three-arm protractor employed on this Project is of plastic and has vernier scales on each of the movable arms enabling angle settings to be made to the nearest two minutes.

Position is plotted by first placing the center line of the middle arm on the middle sextant target and then moving the instrument about until all three arms bisect their respective sextant rargets. A mark is then made through the center of the instrument. This method of position fixing is rapid and can be performed readily on a boat with the aid of plotting board and appropriate maps. This also allows changes to be made in field operations while they are in progress.

Course Protractor

This device is extremely useful for charting boat courses and also for plotting certain types of field data, such as results of synoptic vector cruises. This protractor consists of a plastic square with a compass rose etched on it and a movable plastic arm. When correctly oriented on a chart, a course may be plotted by setting the arm to the desired bearing.

Radio Direction Finder

The radio direction finder operates on the principal of "homing in" on the signal emitted by a radio station. The instrument is operated by rotating the direction-finding antenna until radio signal strength from the desired station is at a minimum (i.e. minimum antenna length presented to the signal). This antenna may be fastened to a hand-held compass or to a special plotting protractor provided with the set. The radio direction finder is less precise than sextant positioning and in this Project's field operations, has been used only

when the 31-foot boat is out of sight of land or navigation buoys. Thus, the instrument is also a safety device for emergency situations such as heavy fog or a storm.

Boat Cranes

Two cranes were mounted on the 31-foot boat for use in current metering, bottom fauna collection, temperature profile work, etc. The cranes were of the type commonly used for current metering from bridges, modified for boat use by removing three rubber-tired wheels and rearranging several structural components. These, in turn, were mounted on two horizontally mounted airplane wheel hub assemblies and fastened to the deck. Thus the aircraft wheel assemblies served both as support and pivots for the cranes, allowing them to be swung about. Interchangeable cable reels were used with the cranes. One was wound with insulated cable and was used for current metering work. The other reel was wound with a heavy-duty steel cable and was used in lowering heavy objects such as the Petersen dredge. All depth readings, when cranes were used for an operation, were taken directly from the footage indicator on the reel. For current metering work in calm weather, the cranes were clamped directly to the stern of the boat, thus allowing three cranes to be mounted simultaneously. This permitted two current meter measurements and a temperature profile to be taken simultaneously.

Depth Finding Equipment

The majority of depth-finding observations were made using a lead line, consisting of a ten-pound lead and shrink-resistant rope marked at half-fathom intervals. The 31-foot and 25-foot boats are equipped with an electronic hull-mounted transducers to which can be attached a Bendix Model No. DR21 battery operated, echo sounding recorder. Because of its simplicity and reliability,

the lead line was found to be more suitable on this Project.

Wind Measuring Instruments

Two methods were used to determine wind velocity and direction in the field. The first method employed a small plastic wind meter operating on the pitot tube principal. This meter has two scales - one reading from 2 to 10 miles per hour, the other reading from 0 to 60+ miles per hour. As this meter is not equipped with a vane arrangement for indicating wind direction, this measurement was determined by compass bearing.

A Navy hand-held wind measuring set was also used. This instrument has a rotor with a vane-type wind speed indicator and has two wind velocity scales, both reading in knots. The instrument is equipped with a wind direction vane which is freed by pulling a trigger. When the vane has oriented itself to the wind direction the trigger is released, locking the vane. Comparison of vane direction with the course heading of the boat at the instant the reading was taken, yields wind direction. Calibrating the inexpensive plastic wind meter readings against the more elaborate Navy equipment proved that the former velocity readings were reliable and were used without correction.

Electronic Thermometer

A resistance-type electronic thermometer was used for all temperature profile and surface temperature runs. This instrument consists of a small sensing element at the end of a 50-foot wire, which in turn, is connected to a small plastic case containing the electronic components and a calibrated temperature scale. A wooden case was built to protect the thermometer with

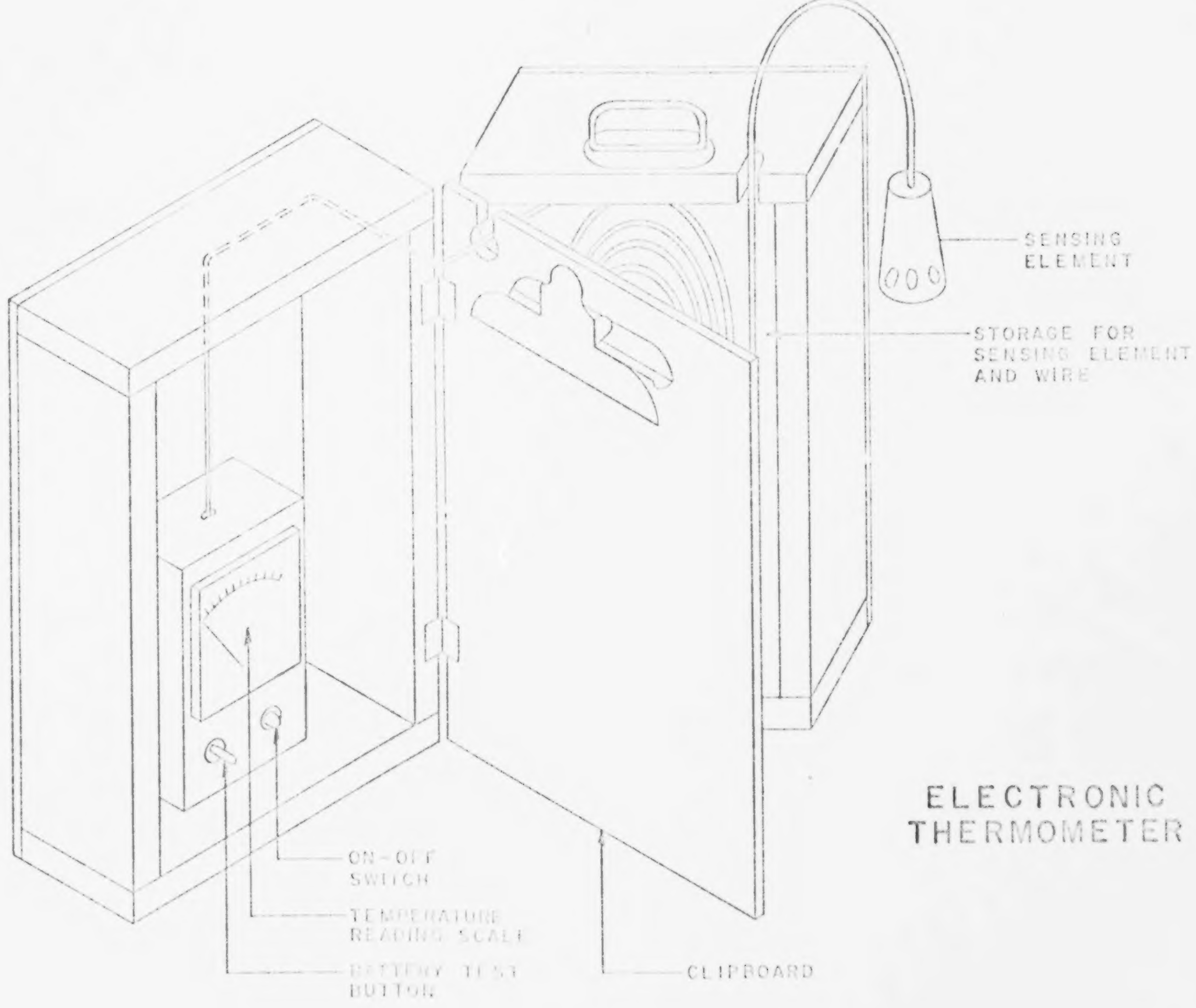
a clip board for recording temperatures and space for the wire and the element. The wire was taped to a heavier steel-center cord as it was felt the wire provided would not be durable enough to support the weights required to make the element sink vertically when used for temperature profile work. In operation, two fifteen-pound weights were hooked to the cord holding the wire and element, then the assembly was lowered by means of a boat crane. A temperature reading to the nearest tenth of a degree centigrade was taken at four-foot intervals. For surface temperature run work, the sensing element was fitted to the same intake used for the fluorometer. The instrument was read and the reading recorded at timed intervals on each run.

Drogues

Two types of drogues, both built by Project personnel, were used for field operations. The first type consisted of a four-foot length of cedar fence post with weights attached by line. The amount of ballast was adjusted so that the float would protrude approximately two feet above the water surface. By replacing the weights with an anchor and adding line, the drogues were used during synoptic vector cruises as temporary reference buoys.

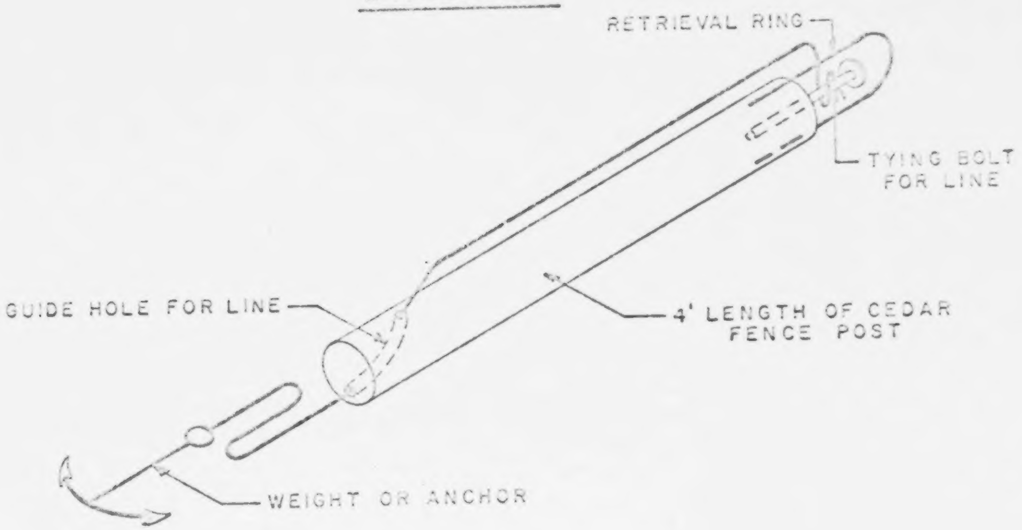
The second type of drogue utilized, consisted of one-quarter inch plywood, four foot square with a weight centered below. These drogues were released along with dye, for photography work from Navy helicopters. All drogues were painted brilliant orange for better visibility.

FIGURE 21

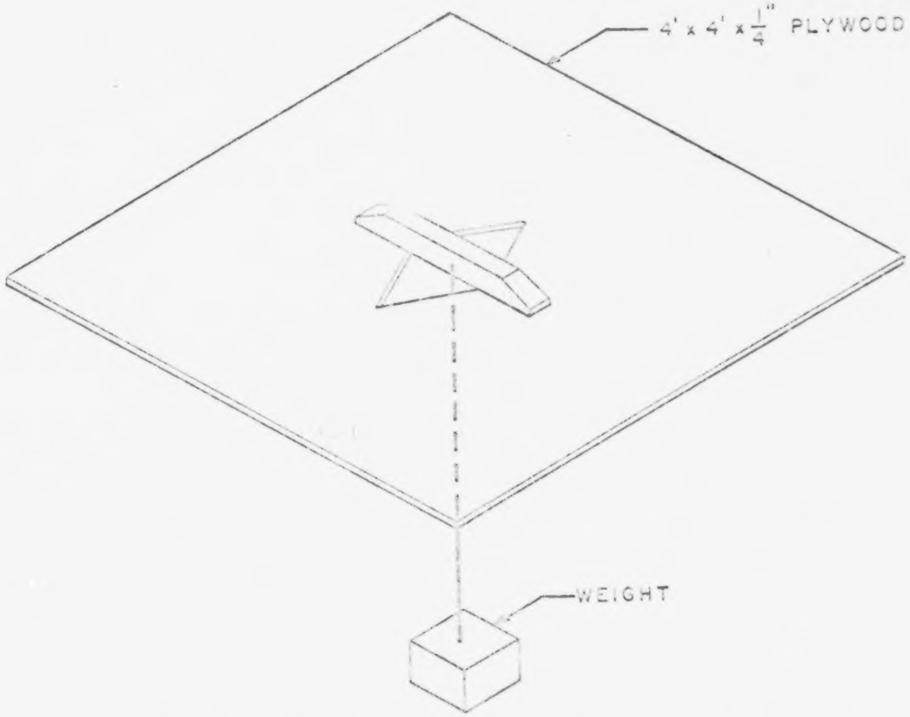


ELECTRONIC THERMOMETER

DROGUES



DROGUE USED FOR FLUOROMETRIC DYE STUDIES AND FOR TEMPORARY MARKER BUOYS



DROGUE USED FOR PHOTOGRAPHIC WORK

Fluorometer

The Turner Model 111 fluorometer is an extremely sensitive instrument capable of detecting Rhodamine B dye in concentrations of less than 0.05 parts per billion. For current tracing work, the instrument was equipped with a recorder and a flow-through sample chamber. Thus, the instrument can be used either for continuous monitoring of dye concentration with time at a fixed location, or for providing a continuous record of dye concentration and location while the boat is moving on course.

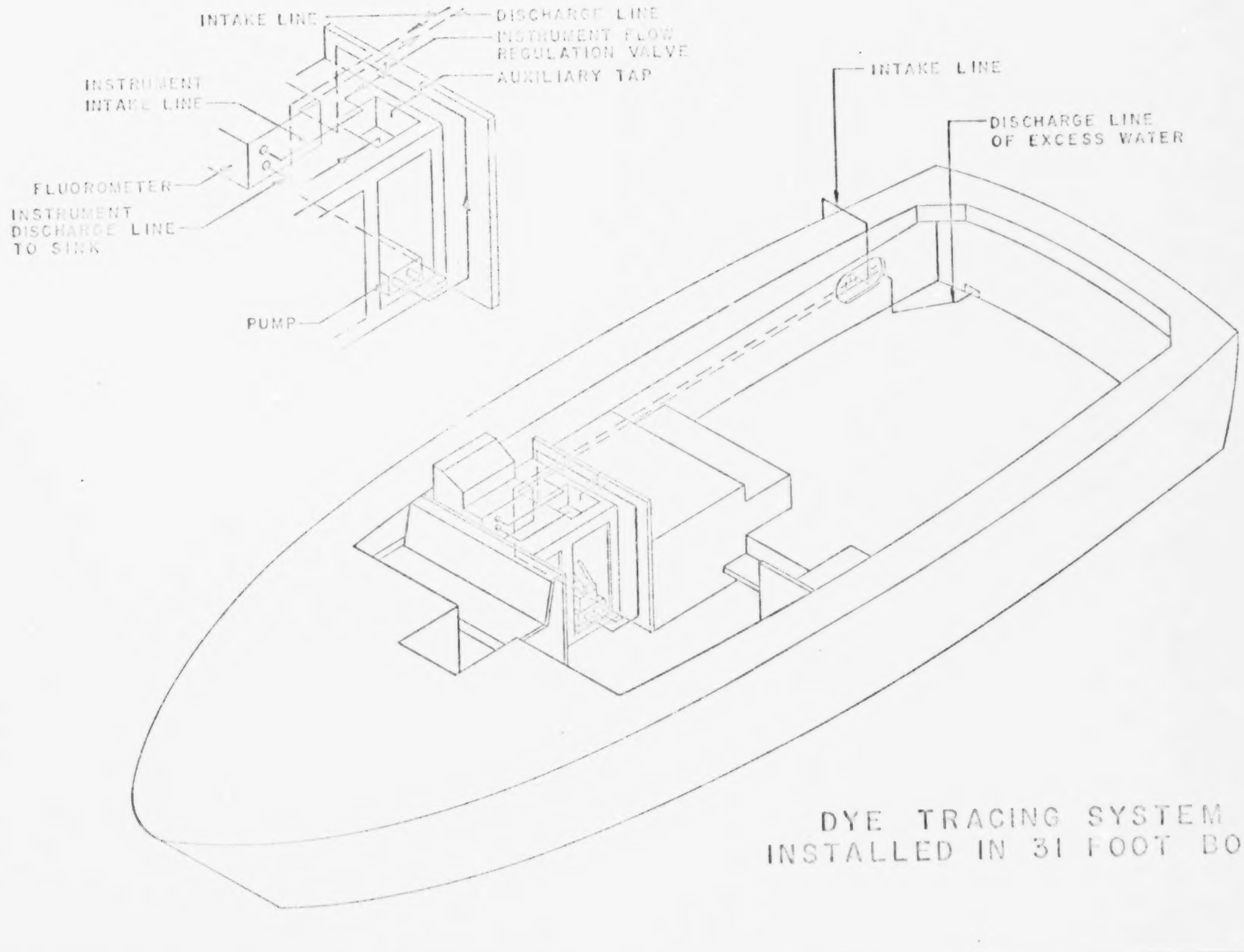
The fluorometer is an optical equivalent of th Wheatstone bridge used in electrical work. Light rays from an ultraviolet lamp pass through a primary filter which extracts light of unwanted wave lengths. This light strikes the sample flowing through a glass chamber (cuvette). The ultraviolet light causes dye particles in the sample to emit light of a different wave length, which in turn, falls upon a secondary filter designed so as to allow light of only this w ve length to pass. This light then strikes a photomultiplier cell. The intensity of this light is "compared" electronically to the intensity of light from a standard source. A servomechanism accomplishes the light intensity balancing procedure and the result is shown on the fluorescence dial on the instrument. Calibr , using known concentrations of Rhodamine B dye, is necessary order to determine a relationship between scale reading on the fluorometer dial and dye concentration. This procedure was done initially and also several times during the course of operations.

Use of the fluorometer on the 31-foot boat required the installation of a pump, a tubing system and intake, and a small electric power converter to

convert the 12-volt d.c. current available on the boat to the 110 a.c. required by the instrument. A diaphragm type pump was chosen for the work as it would not require priming; this being the main drawback of the centrifugal type. A one-inch plastic tubing system for inlet and outlet connections, containing several valves, was installed permanently in the boat. A small rubber tube was tapped into the line to withdraw water for the instrument. As the pump could pump 7 to 8 gallons per minute of water, and the instrument required less than one-half gallon per minute, most of the water was bypassed. Although this may appear inefficient, this has the advantage of allowing the amount of water to the instrument, as well as the pressure on the instrument, to be varie This versatility is important in eliminating air bubbles in the system. Two intake systems were used during the course of operations. The first system utilized consisted of one-inch rubber hose with an elbow and an intake nozzle. Intake depth could be adjusted from the surface to thirty feet. This restricted boat speed however, so that a new intake was constructed of steel pipe and fittings design to withdraw water at a depth of two feet. This intake operated satisfactorily and did permit running at speeds up to 20 feet per second.

Rhodamine B Dye

Rhodamine B is a reddish-purple fluorescent dye with properties that make it especially well-suited to current pattern work. It can be detected in concentrations of less than 0.05 parts per billion, using a fluorometer and proper filters; can be used as a visual tracer, and is harmless to humans and to fish. In addition, this dye will maintain fluorescent properties in the water over a much longer period of time than does most other dyes.

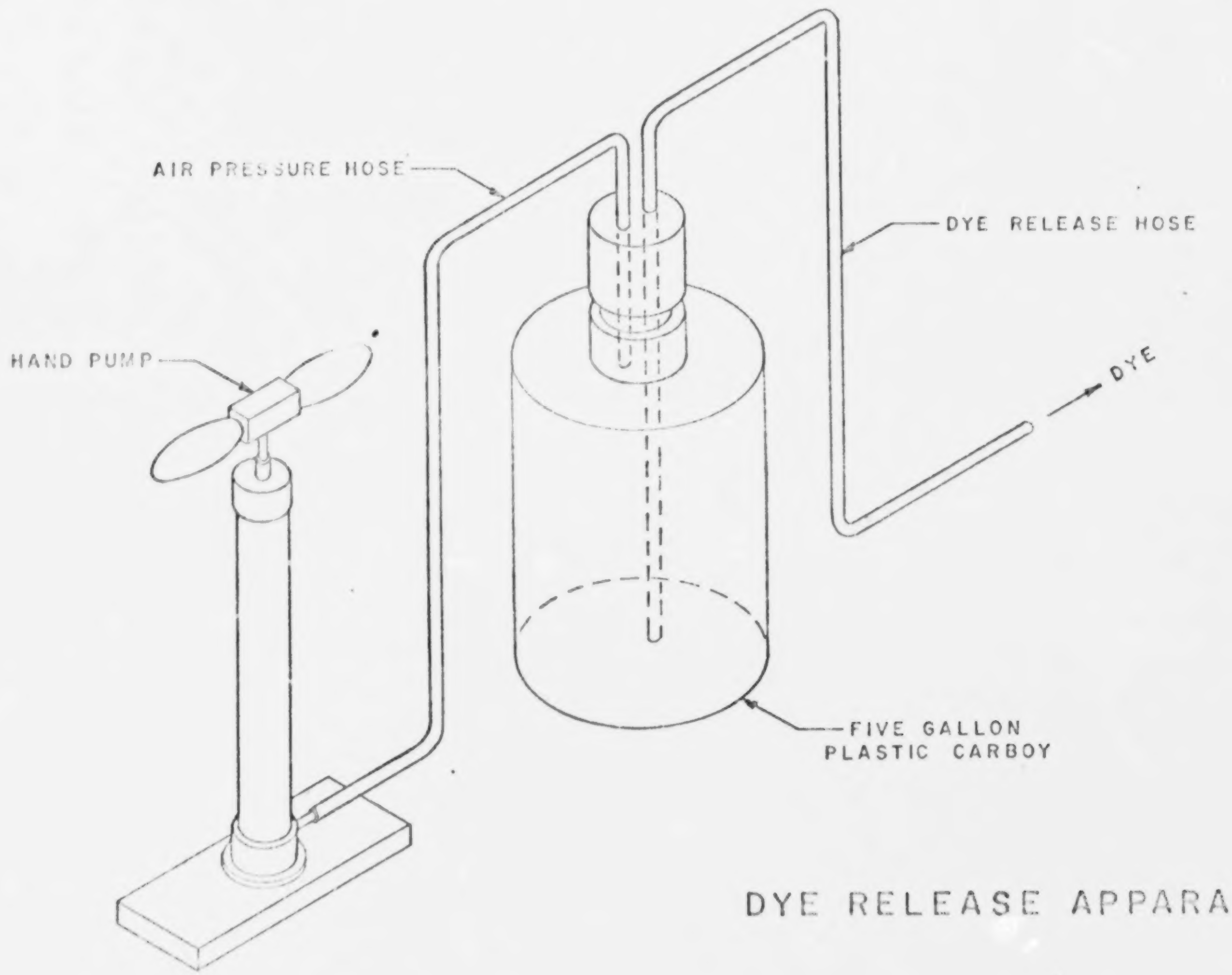


DYE TRACING SYSTEM
INSTALLED IN 31 FOOT BOAT

FIGURE 23

63 A

FIGURE 24



DYE RELEASE APPARATUS

Rhodamine B dye is sold by DuPont de Nemours in solution (40% by weight) with glacial acetic acid. Handling is much more simplified if this form is used rather than the powdered form. One quart of the dye-acetic acid solution (a commonly used dose in this Project's work) costs between \$4 and \$5.

The dye was used both in concentrated and dilute form. A small quantity of concentrated dye poured directly into the water from a quart bottle proved to be the most effective when tracing currents visually (as in synoptic vector cruises).

In fluorometric current tracing work in the Detroit River, a long streak of dye was desired to maximize the likelihood of detecting the dye with the instrument on a cross-sectional run after the dye became too dilute to be seen. This is done by adding one to four quarts of dye (depending on the magnitude of the particular current study) to a 5-gallon carboy and filling the remainder of the jug with water.

Dye Release Apparatus

It was found desirable in some current-tracing work to release Rhodamine B dye in a streak rather than in a slug. A simple system was built consisting of a five-gallon plastic carboy (jug), a tire pump, and two pieces of rubber laboratory tubing. The top of the carboy was fitted with an air hose and a dye dispensing hose. The air hose was connected to the manually operated tire pump. With practice, the rate of dye release could be varied from five to twenty minutes depending on the operator's speed in pumping.

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Current Meters

Current meters used were of the Price type, having a rotor with cups mounted on a vertical axis. The Price type A current meter was used for all Detroit River work as well as for work on some of the larger tributaries. The cable suspension mounting for this meter was used exclusively, both when hand-held and when supported by crane in a boat. The Price pygmy meter with wading rod assembly was used on the smaller tributaries. The pygmy meter is a scaled down version of the type A meter and is used in shallow streams for low velocity work where the latter is inaccurate.

Water Level Recorders

Portable water level recorders (Belfort #5-FW-1) were utilized in conjunction with field operations. These units consist of a float and counterweight connected by a perforated stainless steel tape which is looped over a sprocketed wheel on the body of the recorder. Float movements are transmitted through this wheel to a gear train and cam to a recording pen. The pen records on a chart wrapped about a circular drum driven by a clock mechanism. The rate of rotation of the drum can be altered from one day to eight days by changing gears.

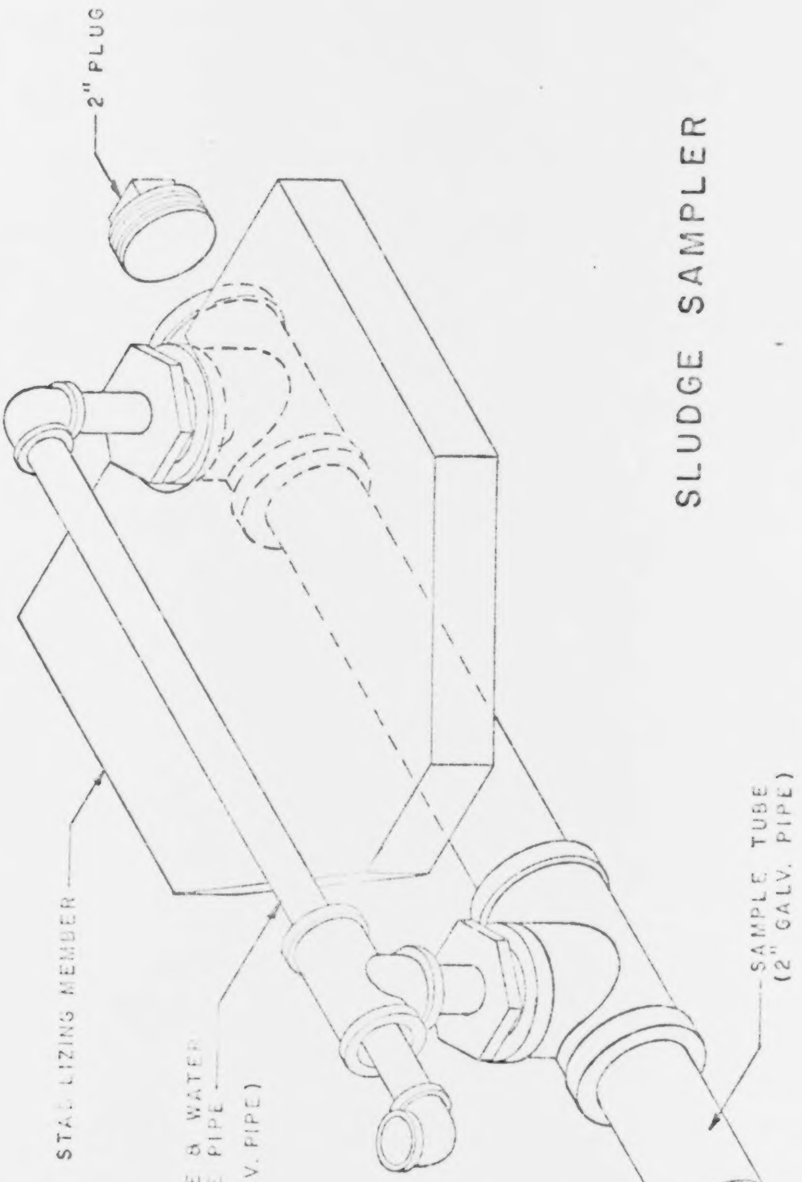
Installation of a water level recorder required the construction of a stilling box and some type of platform mounting for the instrument itself. The stilling boxes were built by project personnel of quarter-inch plywood. Cross-sectional dimensions are approximately one and one-half foot by one foot with lengths varied to meet the individual situation at the proposed

recorder site. A small hole is drilled in the bottom of the stilling box to permit water level in the box to adjust to the water level outside the box, yet not show small transient fluctuations caused by wind action and the passing of small boats.

One water level recorder station was kept in operation continuously from April through November 1963, at the dock used by Project boats. Other recorders were installed as needed at other locations.

Detroit River-Lake Erie Project Sludge Sampler

The sampler developed by the Project for sludge survey purposes consists of a 2-inch diameter tube, about 18 inches long, fitted with a horizontal stabilizing member of wood and a pressure release tube that allows water to exit as the bottom material enters the tube. The horizontal stabilizing member serves a three-fold purpose: 1) adds buoyancy and stability to the sampler while it is being towed behind the boat on the way to the bottom; 2) holds the sampler in upright position on the bottom so that the cutting edge will dig into the bottom material; 3) prevents the sampler from sinking too far into the bottom material, thus taking a sample of the upper layer which is in contact with the water.



SLUDGE SAMPLER

STORM WATER OVERFLOW

AND

DOMESTIC WASTE SURVEYS

SECTION II

67-A

WASTE SURVEYS

DOMESTIC WASTE SURVEYS

Purpose

Comprehensive surveys of the six major sewage treatment plants in this Project's study area were carried out at various times throughout the summer and fall by Project personnel in cooperation with the Michigan Department of Health to determine the waste loads to the river at different seasons of the year.

The plants in question were studied at two separate times. First in the summer during the chlorination season, and then in the autumn after chlorination had ceased. The initial survey of the plants was very detailed, both as to analyses required, and frequency of sampling. The later survey covered only those areas where the initial results showed that a problem existed. The plants originally surveyed were Belle Isle, Detroit, Grosse Ile (Potawatamie Woods Subdivision), Monroe, Trenton, and Wyandotte. After studying the results of the surveys on these plants, it was decided that it was unnecessary to run a second study on the Belle Isle, Grosse Ile, and Trenton Plants.

Survey Dates and Times

Plant surveys were spread over several weeks in order to ease the burden on the laboratories and to allow related outfall and river studies to proceed smoothly. The first survey of the Wyandotte plant was delayed several weeks to allow plant expansion to proceed to a point where the results would be more meaningful.

Dates of the surveys for the various plants are listed below:

June 9 through June 12	Monroe and Grosse Ile
June 16 through June 19	Detroit
June 23 through June 26	Trenton
August 11 through August 14	Wyandotte and Belle Isle
November 4 through November 7	Detroit, Monroe and Wyandotte

The summer surveys all started at midnight on Sunday mornings and extended through four days until midnight of the following Wednesday night. The survey in November started at midnight on Monday morning and extended four days through midnight on the following Thursday.

Analyses Performed

With the exception of the Belle Isle plant, the samples taken during the initial survey were subjected to a comprehensive analytical breakdown. The following analyses were run on the samples taken from the Detroit, Grosse Ile, Monroe, Trenton, and Wyandotte plants during the initial survey.

ABS	Nitrites
Ammonia Nitrogen	Nitrates
BOD	Organic Nitrogen
Chloride	pH
COD	Phenol
Cyanide	Phosphates
Total Coliform	Settleable Solids
Fecal Coliform	Suspended Solids
Fecal Streptococci	Sulphates
Grease	Total Solids
[illegible]	Toxic Metals

Analyses of the Belle Isle plant were curtailed because of the relatively low volume of effluent as well as the fact that the volume of sample obtained was also small; this was due to the fact that samples were taken at the plant by an automatic sampler rather than manually. Analyses run on the

Belle Isle samples were as follows:

pH	Suspended Solids
Phenols	Settleable Solids
Chlorides	Total Coliform
Alkalinity	% Fecal Coliform
BOD	Fecal Streptococcus
COD	

During the second survey in November, analyses were performed only on parameters shown to be significant by the first survey. Analyses were as follows:

pH	Nitrates
Phenols	Nitrites
Alkalinity	Ammonia Nitrogen
Suspended Solids	Organic Nitrogen
Settleable Solids	Total Coliform
Grease	% Fecal Coliform
Phosphates	Fecal Streptococcus

Sampling Procedures

Sampling procedures varied both with individual plants and with the survey. Each plant will now be covered individually.

Grosse Ile - June 9 through June 12

The influent samples for chemical analyses were taken at a temporary weir located in front of the sedimentation tanks. Effluent samples for both chemical and bacteriological analyses were taken as the sewage passed over weirs at the end of the sedimentation tanks. Since the plant has pre-chlorination, the influent bacteriological samples were taken as the sewage entered the wet well.

Bacteriological samples of the effluent were taken every hour on the hour while the influent bacteria samples were taken twice-a-day at 2 a.m. and 2 p.m. Chemical samples were taken on a composite basis with sewage being added to the bottles every hour in amounts directly proportional to the number of pumps running at the time. Since there were periods at the plant during which no pumps were running, on occasion the composites were taken a few minutes before or after the hour. Composites were made up for 12-hour periods with the influent composites running from midnight through 11 a.m. and from noon through 11 p.m. Effluent composites were taken from 1 a.m. through noon and from 1 p.m. through midnight. Three separate jugs were used for both influent and effluent composites. One jug contained a phosphoric acid and copper sulphate preservative for the phenol analysis; the second contained sodium hydroxide for the cyanide analysis, and the third did not have any preservative but was kept cold by placing it in an ice chest. Samples were taken manually by means of a sampling pole identical to those used by the Project for river sampling.

Monroe - June 9 through June 12

Influent samples for both chemical and bacteriological analyses were taken at a point between the grit chamber and the sedimentation tanks. All effluent samples were taken through an opening over the outfall sewer about 25 feet above where the sewer empties its contents into the Raisin River.

Sampling procedures were identical to Grosse Ile except that composites were made in amounts proportional to that going through the plant which were

recorded by a meter built into the plant. Samples were taken manually by means of a sampling pole identical to those used by the Project for river sampling.

Detroit - June 16 through June 19

All samples were taken through sampling lines leading from the plant directly to the laboratory inside the plant. The influent tap line is located between the grit chamber and the sedimentation tanks. The effluent tap line is located in the outfall sewer. During normal flow, an effluent sample reaches the laboratory about ten minutes before the sample sewage reaches the river.

Sampling procedures were identical to the above plants except that the tap lines were used instead of the manual samplers. Composites were made in proportion to the meter flow in the plant at the time of sampling. Five additional effluent bacteriological samples were taken and held for the required ten minutes before chlorine neutralization, in order to adjust for the ten-minute additional detention time in the outfall sewer.

Trenton - June 23 through June 26

Effluent chemical and bacteriological samples were taken as the effluent entered the outfall line after passing through the chlorine contact chamber. Influent chemical samples were taken as the sewage entered the sedimentation tanks while the influent bacteriological samples were taken as the sewage entered the plant in order to avoid the pre-chlorination. Sampling procedure was identical to that done in the previous plants and

composites were made on the basis of the number of pumps running, their size, and the duration of the run. Samples were taken manually by means of a sampling pole identical to those used by the Project for river sampling.

Wyandotte - August 11 through August 14

Influent chemical and bacteriological samples were taken between the grit chamber and the sedimentation tanks. All effluent samples were taken as the sewage entered the outfall sewer.

Belle Isle - August 11 through August 14

Influent bacteriological and chemical samples were taken at a location in front of the sedimentation tank. Effluent bacteriological and chemical samples were taken at a temporary weir as the sewage left the sedimentation tanks.

The sampling program at this plant was considerably different from that done at previous plants. Influent and effluent chemical samples were taken automatically by devices designed to take samples proportional to the flow. The use of these samplers prohibited collection of three separate influent and effluent composites as was done at the other plants. Furthermore, the sample collected was in no way refrigerated. Bacteriological samples were taken of the influent twice daily at 2 a.m. and 2 p.m., when the automatic sampler was being serviced.

Detroit - November 4 through November 7

Influent and effluent bacteriological samples were taken from the tap

lines as in the previous survey. Bacteriological samples were taken of the influent at 2 a.m. and 2 p.m.; the effluent samples were taken at 3 a.m., 9 a.m., 3 p.m. and 9 p.m. There were no special samples prepared after a ten-minute delay as was done in the previous survey at this plant. Chemical composites were taken every hour in proportion to the flow at the time of sampling, but no composites were made of either the influent or effluent for cyanide analyses. Influent as well as effluent composites were, therefore, prepared in two jugs each; one containing copper sulphate and phosphoric acid for phenol analyses, and one jug without preservative for the remaining analyses. Influent composites were taken from midnight through 11 a.m. and from noon through 11 p.m., while the effluent composites were taken from 1 a.m. through noon and from 1 p.m. through midnight, which was the same as for the summer survey.

Monroe - November 4 through November 7

All influent and effluent chemical and bacteriological samples were taken just after the grit chamber and at the end of the outfall line, respectively.

Bacteriological influent samples were taken at 2 a.m. and 2 p.m., while effluent samples were taken at 3 a.m., 9 a.m., 3 p.m., and 9 p.m. Chemical samples were taken every hour and composited according to the measured flow at the time of sampling. Composites were prepared in unrefrigerated bottles as well as ones containing copper sulphate and phosphoric acid. Samples were taken manually by means of a sampling pole identical to those used by the Project for river work.

Wyandotte - November 4 through November 7

Influent samples during this survey were taken from an influent tap line drawing sewage at a point below the grit chamber (in the previous survey the influent samples were taken manually). Effluent samples were taken as the sewage passed over the discharge weir.

The sampling schedules were the same as for the previous two plants and chemical samples were composited according to the measured flow at the time of sampling. The effluent samples were taken manually by means of a sampling pole identical to those used by the Project for river work.

Sample Preparation for the Laboratory

Summer Survey Excluding Belle Isle

As was mentioned in a previous section, chemical composites of both influent and effluent were placed in three separate jugs. One contained preservative for the phenol analyses, one contained preservative for the cyanide analyses, and one, without preservative, was kept under refrigeration.

The compositing schedule for all plants was designed so that a minimum of $1\frac{1}{2}$ gallons of sample was obtained in each jug. The figure of $1\frac{1}{2}$ gallons was arrived at after adding together the amounts needed for the various analyses. It was not necessary to gather $1\frac{1}{2}$ gallons of sample in the jugs for phenol and cyanide analyses, but it was decided that there would be less chance for error if equal amounts were added to each jug. When the sample collectors arrived, therefore, the contents of the cyanide and phenol jugs were thoroughly stirred and one liter of the contents was

then poured into the proper polyethelene bottles. The remainder of these samples was then discarded. Refrigerated samples in their entirety were brought back to the laboratory along with the bacteria samples. Upon arrival at the laboratory, the contents of the refrigerated jugs were placed in four, separate smaller bottles. The first of these was a ½-gallon glass bottle to be used for separate laboratory analyses. The second was a 2-liter polyethelene bottle containing nitric acid preservative which was set aside for later compositing with its counterpart from the other 12-hour period and subsequent shipment to Great Lakes-Illinois River Basins Project for the toxic metals and iron analyses. The third bottle was also a 2-liter polyethelene which contained no preservative and also was set aside for later compositing with its counterpart from the other 12-hour period and subsequent shipment to Great Lakes-Illinois River Basins Project for ABS, sulphate and phosphate analyses. The fourth bottle was a ½-gallon glass container filled with the remainder of the sewage for the grease analysis run in our laboratory. The samples for Great Lakes-Illinois River Basins Project were combined on an equal volume basis for shipment as 24-hour composites. A more accurate 24-hour compositing procedure involving the use of the flow records was not undertaken, due primarily, to the difficulty in getting immediate records.

Belle Isle Survey

No samples were sent to Great Lakes-Illinois River Basins Project from the Belle Isle sewage treatment plant, and therefore, the only sample preparation consisted of pouring the composites into the proper ½-gallon glass

bottles as well as bringing the bacteria samples back to the laboratory.

Autumn Survey

Chemical composites of both influent and effluents were placed in two separate jugs, one containing preservative for the phenol analysis and the other containing no preservative. Sine the BOD test was not run during this survey, the latter jugs were not refrigerated.

When the sample collectors arrived at the plants, the contents of all jugs were thoroughly mixed and one liter of sewage from each of the phenol jugs was poured into the proper polyethelene bottles. One gallon of unpreserved sewage from each of the remaining two jugs was poured into two ½-gallon glass bottles. All bottles were brought back to the laboratory (total of six bottles) where they were delivered without any further pouring or transfer. No samples were sent to Great Lakes-Illinois River Basins Project.

<u>Personnel Involved</u>

Plans for the surveys were formulated by the Michigan Department of Health and by the Detroit River-Lake Erie Project. All prior arrangements with the sewage treatment plant operators were made by the Michigan Department of Health; installation of temporary weirs, water level recorders and automatic samplers was also performed by the Health Department. The actual in-plant sampling operations were carried out throughout both surveys by the plant personnel, with the exception of Belle Isle, where the sampling was automated. All sample bottle collections, processing, shipments, and

analyses were done by personnel of the Detroit River-Lake Erie Project, and sampling equipment, bottles and preservatives were furnished by the Detroit River-Lake Erie Project. Water level recorders and weirs were provided by both the Detroit River-Lake Erie Project and the Michigan Department of Health. Automatic sampling equipment for the Belle Isle plant was provided by the Michigan Department of Health.

INDUSTRIAL WASTE SURVEYS

Purpose

The industrial waste program of the Detroit River-Lake Erie Project was divided into two segments, the first being a comprehensive survey within the industry, measuring the quality and quantity of the raw water and waste discharges. These were short, intensive surveys featuring composite sampling to determine the sources of waste which may have a bearing upon the water quality in the Michigan area of the Detroit River and Lake Erie. The second approach was an outfall sampling program whereby many spot collections were made at all the outfalls which could be reached without stepping inside the confines of the industrial properties. Here the purpose was to add reliability to the comprehensive surveys and to provide a series of results over a long period of time to measure changing plant process and production. Effectiveness of newly installed treatment methods could also be evaluated. Another very vital purpose of the spot sampling was to determine if the comprehensive survey was typical of a normal day's operation in the plant, or whether more careful controls of waste processes were being followed because the survey was being conducted. It seemed that, in several cases, the theory worked out that the industry was doing a finer job during the survey than other times of the year. In fact, because of this, repeat comprehensive surveys were performed on several of the industries.

The entire industrial waste program provided information whereby recommendations could be made and a plan worked out to control the waste discharges degrading the water quality in the study waters. Table 1 shows the name, location and outfalls of the industries studied.

Comprehensive Surveys

At the beginning of the Project, many conferences were held with agencies within the State of Michigan to provide information for the planning of the study. Due to the nature of the intrastate enforcement actions, the Project worked very closely with the two State agencies having jurisdiction over water pollution control matters and, in the case of industrial wastes, this was the Michigan Water Resources Commission.

An excellent cooperative effort and close working relationship with the Michigan Water Resources Commission was started at the outset. Several conferences were held to plan the industrial waste programs. The major issue resolved was who would handle the field work in the comprehensive sampling program. For the reasons given, it was decided that the Michigan Water Resources Commission could best handle this phase of the study:

1. The Commission would have no problem getting inside the plant property to plan and carry out the surveys.

2. The Public Health Service had no mechanism besides legal action to get inside plant property.

3. The Michigan Water Resources Commission was considerably more familiar with each industry in question and perhaps would be able to shed more light on the information obtained.

Following this decision, the program began immediately with the Commission making the arrangements and performing the field work at each industrial location, and the Project laboratory performing the analytical chemistry on the samples collected in each industry.

The Public Health Service reviewed the field work of the Michigan Water Resources Commission during some of the earlier surveys in order to be familiar with the operation.

The order in which each industrial survey would be carried out and the type of information collected at each industry was then determined. Table 2 presents the form that was used and the type of information collected.

In all, 41 industrial corporations or major divisions and 116 waste effluent outfalls were studied.

Sampling installations were set up at the raw water intakes and the industrial waste outfalls. Samples were collected automatically every 15 minutes for a period of usually 12 hours and composited according to flow. The sampling usually continued for two days. In some cases, longer studies were followed because of the magnitude and complexity of the problem; some studies were also repeated at a later date. Where reliable and continuous flow records were not available, a flow measuring setup was installed consisting of either a V-notch or rectangular weir and an L&S type F water level recorder to measure the height of water over the weir.[1] Figure demonstrates a typical setup. In a few cases where temporary flow-measuring equipment was impractical to install, flow volumes were either estimated or obtained from company records.

Following collection, the samples were transported immediately to the Detroit River-Lake Erie Project laboratory for analytical determinations. Table 3 represents the chemical parameters studied in most cases. It was felt that, although many of the parameters studied would be of little value in the interpretation of the industrial waste results, it would be best to

(1) Black, H.H., "Procedures for Sampling and Measuring Industrial Wastes." Sewage and Industrial Wastes, 24:45, January 1952.

approach it from a very comprehensive manner so as not to overlook anything. In a few special cases other parameters such as cyanide, aluminum, fluorides, turbidity, and fecal coliform determinations were performed.

TABLE 2. INDUSTRIAL WASTE SURVEY FORM

Name of Industrial Company

Industrial Division

Address

Organization of Survey

Dates of Survey

Purpose of the Survey

Personnel Participating

a. Industry

b. Michigan Water Resources Commission

c. U.S. Public Health Service

Location of Plant

Raw Material Used per Unit Time

Production per Unit Time

Operations, Hours and Days of the Week

Employee

Water Supply - source and amount

a. Potable

b. Sanitary

c. Process

d. Cooling

Sanitary Waste - Discharge location and/or treatment method

Process Waste - Discharge location and/or treatment method

Description of Waste Reduction Measures

TABLE 2. INDUSTRIAL WASTE SURVEY FORM (CONTINUED)

Survey Procedures

a. Sample Collection Methods

b. Flow Measurement Methods

c. Laboratory Analytical Results

d. Flow Volumes Each Outfall or Process

e. Calculations including Loadings

Conclusions and Recommendations

Summary

TABLE 3. CHEMICAL PARAMETERS STUDIED

pH	Calcium
Phenols, ppb	Magnesium
Chlorides	Total Iron
Alkalinity	Silicates
COD	Sulfates
BOD	Dissolved Solids
Total Coliform	Suspended Solids
Nitrates	Settleable Solids
Nitrites	Copper
Ammonia Nitrogen	Cadmium
Organic Nitrogen	Nickel
Phosphates	Zinc
ABS	Lead
Sodium	Total Chromium
Potassium	Oil

Industrial Waste Outfall Surveys

Reconnaissance surveys with the assistance of the Michigan Water Resources Commission helped locate the industrial waste outfalls. All outfalls observed from the industries shown on Figures 7 and 8, Section I, which either were discharging or were thought to discharge at any time were studied and sampled. Altogether, 130 outfalls were investigated with 1,176 collections being made.

In most cases, samples were collected with use of the Project boats, using a large can fastened to the end of a long pole to reach into the outfall. During the earlier part of 1962, the outfall samples were collected by taking the regular industrial waste inspection trips with the Michigan Water Resources Commission boat and personnel. Composite samples were collected for a short time in July 1963 at two of the Pennsalt Chemical Company outfalls on Monguagon Creek and again in October 1963 at the

Monroe area industries. All other times, grab samples were collected. Samples were not collected in any manner in relation to flow although flow volumes were estimated at each outfall a few times. After much thought, it was deemed impractical to attempt making reliable flow measurements at the outfalls.

The large majority of the samples were collected during the daylight hours; however, each outfall was sampled at night as often as possible to give a better picture of the complete waste problem.

Emphasis was placed on spot sampling at different times of the year because of the availability of field crews and the volume of samples being handled by the Project laboratory. Table 4 shows the frequency of collection of industrial waste spot samples.

TABLE 4. FREQUENCY OF INDUSTRIAL WASTE OUTFALL SAMPLES

	Week(1962)	No. of Samples
August	6	16
	13	15
	20	14
	27	16
September	3	
	10	14
	17	16
	24	17
October	1	16
	8	16
	15	16

	Week(1962)	No. of Samples
October	22	16
	29	16
November	5	
	12	16
	19	16
	26	
December	3	24
	10	
	17	
	24	
	31	

	Week(1963)	No. of Samples
January	7	10
	14	
	21	
	28	
February	4	
	11	27
	18	34
	25	32
March	4	27
	11	16
	18	12
	25	53
April	[illegible]	
		3
	15	21
	22	34
August	19	
	26	114
September	2	
	9	10
	16	12
	23	2
	30	8
October	7	
	14	25
	21	14

	Week(1963)	No. of Samples
April	29	29
May	8	7
	13	7
	22	3
	29	13
June	3	
	10	
	17	
	24	
July	1	
	8	28
	15	71
	22	131
	29	28
August	5	
	12	11
October	28	
November	4	
	11	
	18	41
	25	16
	2	57
	9	36
	16	
	23	
	30	

Also, more emphasis was placed on certain outfalls than others. This is shown on Table 1.

TABLE 1 NUMBER OF SAMPLES BY INDUSTRIAL OUTFALL

Industry	Outfall #	Location	No. of Samples
Allied Chemical Corporation			
Plastics Division	1	Old Channel Rouge	16
General Chemical Division	1	Rouge River	16
	2	" "	18
Semet Solvay Division	1	Old Channel Rouge	6
Solvay Process Division	1	" " "	14
	2	" " "	2
	3	" " "	13
	4	" " "	11
	5	" " "	11
	6	" " "	9
	7	Detroit River	8
American Agricultural Corporation	1	Rouge River	18
	2	" "	0
	3	" "	0
	4	" "	14
Anaconda American Brass Corporation	1	Detroit River	0
	2	" "	0
	3	" "	0
	4	" "	0
American Cement Corporation			
Peerless Division	1	Rouge River	2
	2	" "	4
	3	Old Channel Rouge	17
	4	" " "	0
Chrysler Corporation			
Amplex Division	1	Detroit River	8
Cycleweld Division	1	" "	8
Engine Division	1	Elizabeth Park - Detroit River	23
County Drain #5	1	Detroit River	0
Dana Corporation	1	Nicholson Slip - Detroit River	1
	2	" "	0
Darling and Company	1	Rouge River	2
	2	" "	1
Dupont Corporation	1	Detroit River	12
Firestone Tire and Rubber Company	1	Detroit River	7
	1A	" "	1
	2	" "	2

TABLE 1 NUMBER OF SAMPLES BY INDUSTRIAL OUTFALL

Industry	Outfall #	Location	No. of Samples
Ford Motor Company	Rouge Plant Tailrace	Rouge River	17
	Slip Weirs	" "	19
	Ruolo Creek	" "	20
	Foundry	" "	20
	Naval Barracks	" "	18
	#7	" "	2
	#8	" "	1
	Gate 11	" "	5
	Dix Street	" "	4
Fuel Oil Corporation	1	Nicholson Slip - Detroit River	2
Great Lakes Steel Corporation			
Ecorse Rolling Mill	1	Nicholson Slip - Detroit River	8
	2	" " "	19
	3	" " "	19
	4	" " "	18
	5	" " "	4
	6	" " "	1
	7	" " "	4
	8	" " "	0
	9	" " "	0
	10	" " "	0
	11	" " "	3
	12	" " "	10
Blast Furnace Division (Zug Island)	1	Detroit River	0
	2	" "	11
	3	" "	6
	4	" "	13
	5	" "	6
	6	" "	9
	7	" "	13
	8	" "	6
	9	" "	8
	10	" "	0
	11	" "	7
	12	Old Channel Rouge	2
	13	" " "	2
	14	" " "	2
80" Strip Mill	1	Detroit River	13
	2	" "	13
Koppers Corporation	1	Detroit River	2
Ed Levy Company	1	Rouge River	7
McKinstry Avenue Sewer	1	Detroit River	4
McLouth Steel Corporation Gibraltar	1	Detroit River	2

TABLE _1_ NUMBER OF SAMPLES BY INDUSTRIAL OUTFALL

Industry	Outfall #	Location	No. of Samples
McLouth Steel Corporation			
Trenton	1	Detroit River	18
	2	" "	18
	3	" "	15
	4	" "	14
Mobil Oil Corporation	1	" "	4
Monsanto Chemical Corporation	1	" "	12
Parke Davis and Company	1	" "	12
	2	" "	11
	3	" "	12
	4	" "	0
Pennsalt Chemical Corporation			
East Plant	1	Detroit River	18
	2	" "	18
	3	" "	16
	4	" "	19
	5	" "	6
West Plant (Monguagon Creek)	1	Monguagon Creek	44
	2	" "	41
Revere Copper and Brass Corporation	1	Detroit River	5
	2	" "	7
	3	" "	8
Schroeder Avenue Sewer	1	Detroit River	7
	2	" "	5
Scott Paper Company	1	Old Channel Rouge	17
Shawinigan Resins Corporation	1	Detroit River	10
Tank Farms	1	Rouge River	0
U.S. Rubber Company	1	Detroit River	9
	2	" "	7
Wyandotte Chemical Corporation			
North Plant	1	Detroit River	19
	2	" "	2
	2A	" "	1
	3	" "	14
	4	" "	10
	4A	" "	1
South Plant	1	" "	15
	2	" "	20
	3	" "	19
	4	" "	3

TABLE __ NUMBER OF SAMPLES BY INDUSTRIAL OUTFALL

Industry	Outfall #	Location	No. of Samples
Wyandotte Chemical Corporation South Plant	5	Detroit River	3
Wye Street Sewer	1	Detroit River	22
Ford Motor Company - Monroe	1	Raisin River	1
	2	" "	1
	3	" "	1
	4	" "	0
Consolidated Paper Company South Plant	1	Raisin River	21
	2	" "	20
	3	" "	20
North Plant	1	" "	21
West Plant	1	" "	0
Monroe Auto Equipment Company	1	Raisin River	0
Monroe Steel Casting Company	1	Raisin River	1
River Raisin Paper Company	1	Mason Run - Raisin River	21
Monroe Paper Products	1	Raisin River	21
Total	130		1,176

As the study progressed, more outfalls were discovered and added to the field sheet. Industrial waste outfalls,which were inaccessible either by being submerged.or inside company property,were collected upon request by the Michigan Water Resources Commission. At each outfall, time, temperature, and observations were recorded. An example of the field record form used is shown in Table __.

After collection, the samples were brought to the Project laboratory for immediate analyses. With the limitations of the laboratory in mind, the following determinations were regularly attempted on all the samples collected:

pH

Chlorides

Suspended Solids

Phenols

Oil

STORM WATER OVERFLOW

Automatic Sampling of Overflow

Sites of Overflow Monitoring Equipment

Two basic locations were selected for the storm water overflow sampling stations. One was the City of Detroit which has a combined sewerage system, and the other was the City of Ann Arbor which has a separate storm water system. Ann Arbor is located about 40 miles west-southwest of Detroit and, because of this, its climate and rainfall is very comparable to that of Detroit.

In Ann Arbor, the Allen Creek drainage system was selected while the Conners Creek system was selected for monitoring in Detroit. The selection of this latter system necessitated the installation of two sampling locations. One of these is located where the system empties into Conners Creek and the other is located at the end of a relief sewer for the system which empties into the Detroit River about four miles below Conners Creek.

Construction Details of Overflow Sites

CONNERS CREEK: The Conners Creek sewerage system ends in a large gate house about 1,500 feet above the head of Conners Creek. A triple-barrel underground box sewer connects the gate house with the creek. This connecting sewer always contains water at the level of the Detroit River. There are nine independent 10'x10' flap gates in the gate house. The gates are designed so that when the water on the river side is highest, the gates are closed, but when the water level in the sewerage system exceeds the river level, the gates swing open and allow the sewage to pass on into Conners Creek and eventually

enter the Detroit River.

The installations at all overflow locations consist of two basic systems; one is the sampler activation and supply system which will be covered individually for each site, and the other is the automatic sampling mechanism itself, which is essentially the same for all sites and which will be covered in another section of this report.

The activation system at Conners Creek consists basically of a proximity switch located at the bottom of one of the overflow flap gates. When the gate swings open, the switch closes the circuit and provides current to both the automatic sampling mechanism as well as a one-horsepower submersible pump used to supply sewage to the sampler. The pump is located in a steel cradle at an elevation low enough in the sewer to assure submergence before it is operating. During operation, the pump lifts the sewage about 10 feet in a 3-inch neoprene hose to a 3" x ½" tee followed by a throttling valve. A ½-inch plastic hose runs from the tee to the automatic sampler and the throttling valve is used to regulate the amount of flow passing through this hose to the sampler. The majority of the sewage passes through the throttling valve and is returned to the sewer.

When flow through the gates is marginal, there is a tendency for them to flutter. This, of course, will cause the sampling equipment to turn on and off several times within a few minutes. To prevent this, an electrical metering device was installed which does not allow the system to turn on until the gates have been open for a preset number of minutes.

Flow measurement is accomplished by the placement of floats on both sides of the gates together with proper recording equipment. Head differential be-

tween the sewage in the system and the river can therefore be determined during an overflow, and with the correlation of these head differentials and actually measured flows, a fairly accurate measurement of total flow can be obtained.

JEFFERSON AND LEIB: The Leib Street sewer is a relief for the Conners Creek system. When the sewage reaches Jefferson Avenue during normal flow, it turns and passes through a regulator chamber into the Jefferson Interceptor sewer. During conditions of storm water runoff, however, the regulators close when the flow becomes excessive, and the sewage then rises until it reaches the elevation of a nearby overflow barrier. It then passes over this barrier or weir, travels on for about 1,500 feet in an underground box sewer, and then empties into the Detroit River. The activation of the pump and sampler at Leib is accomplished by the use of a float switch located on the wall of the sewer; when the sewage causes the float to rise to the level of the bottom of the overflow weir, the switch engages and the pump and sampler are placed into operation. The pump is a one-horsepower submersible pump identical to that installed at Conners Creek. The sewage is transported about 10 feet vertically and 25 feet horizontally in a 3-inch neoprene hose to a nearby manhole. In the manhole, the sewage passes through a 3" x ½" tee and throttling valve. The majority of the sewage then passes through the valve and back into the sewer. An amount, regulated by the throttling valve, is carried about another 25 feet through a ½-inch plastic hose and into a small woodeh structure containing the automatic sampler as well as flow monitoring equipment.

Flow depth over the weir is measured by an electric drive Bristol 6-inch strip chart recorder in conjunction with a bubbler-type liquid level gage.

invert of the sewer. A float switch with modifications for the high velocity encountered in the sewer is also mounted on the wall and set to activate the entire system when the water reaches a level high enough to submerge the pump. The sewage is lifted about 8 feet vertically and 10 feet horizontally along the wing wall of the sewer in a 3-inch neoprene hose; the sewage then passes through a 3" x $\frac{1}{2}$" tee followed by a throttling valve. As at the other installations, most of the sewage passes through the valve and back into the sewer, while a small amount is forced through a $\frac{1}{2}$-inch plastic hose to the sampler. The sampler at Ann Arbor is located in a small steel shed about 25 feet away from the wing wall of the sewer. The flow-monitoring equipment consists of an electric drive Bristol 6-inch strip chart recorder in conjunction with a bubbler-type liquid level gage and its operation is identical to that at Leib. A correlation between water level in the sewer and flow can be established by proper stream gaging of the sewer during periods of runoff.

Details of Automatic Samplers

At the present time, the Detroit River-Lake Erie Project has five automatic samplers; three of these samplers are always at the overflow locations during the overflow season, and the other two are kept as replacements and/or demonstrators.

The samplers are all constantly being modified and improved, and because of this, all five of them are different from each other in the minor details. The original samplers had a wiring system which required 5 individual timers; now, however, all but one use a wiring system which requires only 4 timers.

NARRATIVE DESCRIPTION OF SAMPLERS: As can be seen from the accompanying drawing, the sampler consists of a circular table with 24 holes drilled uniformly around its circumference. A sterile bacteria bottle is placed in each hole. The table is mounted on wheels and is driven in a clockwise direction (looking from above) by a motiondiser located under it which is not shown on the drawing. The actual samples are taken by means of the mechanism located on the right side of the device. During operation, sewage enters the sampler by means of a ½-inch hose attached to the vertical tube on the sampler (1). When a sample is not being taken, the sewage passes on through the sampler and out the discharge line (2). When a sample is taken, a solenoid (3) pulls the intake pipe to the left and the sewage then passes down into the bottle below. The actual time that the solenoid is engaged and the sample is being taken is usually less than 1½ seconds and this time is controlled by an industrial timer (4). As soon as the sample has been taken, the motiondiser is engaged and moves the table to the next bottle. Control over where the motiondiser stops is achieved by the microswitch (5), located beneath the solenoid. When the switch drops into one of the small holes shown on the turntable, the current is shut off to the motiondiser. The three box-like structures located on the left side of the sampler (6, 7,) perform all of the device's other time functions. In order [illegible] a sample within a minute or so after the entire mechan[illegible] has been activated, a separate timer with its own setting is required; in the drawing, this is the timer labelled (6). The construction of the entire mechanism is such that samples would be taken repeatedly at the intervals set on this timer unless it is removed from the circuit after the initial sample. This timer is taken out of the circuit by the timer which is

labelled (7). After the initial sample, all subsequent sample times are controlled by the end timer ( ). Another microswitch is located on the apparatus (9) for the purpose of shutting the sampler off after one complete revolution of the turntable has taken place. This prevents any bottles from receiving a double sample. With the exception of the electrical equipment, the sampler consists primarily of aluminum.

NARRATIVE DESCRIPTION OF ELECTRICAL OPERATION OF SAMPLER: A pictorial description of the sampler's electrical pattern at any instant of operation has been prepared and should be followed simultaneously while reading this description.

The Paragon timers all operate basically as follows: to make the timing mechanism work, it is necessary to complete a circuit from terminals 9 as well as 10 to terminal 5. If a lead is connected to terminal 9 or 10 alone, and the other is connected to terminal 5, the timer will not run. In addition to the timer's circuit, there are two other independent circuits in each timer. The first of these controls terminals 6, 7 and 8. Power is normally fed into this circuit through terminal 8, and during the actual timer operation, terminal 8 is connected directly to terminal 6. After the preset time on the device has expired, terminal 8 is immediately disconnected from terminal 6 and power is transferred over to terminal 7. This terminal will then remain "hot" until the power to the timing circuit is cut off. When power is again supplied to the timing circuit, terminal 6 will again be "hot" until the set time has again expired. The third curcuit in the mechanism controls terminals 1, 2, and 3 (terminal 4 is a junction terminal only). Power is normally fed into this circuit through terminal 3. As long as power is

supplied to the timer circuit regardless of whether or not the set time has elapsed, terminal 2 will be "hot". Only when power has been cut off to the timer circuit will terminal 1 become "hot" instead of terminal 2. It is seen, then, that terminals 6 and 7 change over when the timer expires while terminals 1 and 2 change over only when power is actually cut off to the timer circuit.

The industrial timer also consists of a timer circuit which controls terminals L1, L2 and CL2. A circuit from L1 as well as CL2 to L2 must be completed in order for the timer mechanism itself to run. The other circuit in the industrial timer controls terminals C, NC, and NO. Power is normally supplied to this circuit through terminal C. When the timer is actually running, terminal NC is "hot". After the preset time has expired, terminal NO becomes "hot" and remains so until the power to the timer circuit has been cut.

When the sampler receives current initially, all three Paragon timers are in operation. The timer circuits of the 132 timer and the outer 112 receive their power from the main inlet line, while the inner 112 receives its power through the outer 112 timer. The industrial timer does not operate at this time because there is not a ground to its timer circuit.

If the timers are set properly, the first one to expire is the middle 112. Upon expiration, its terminal 7 becomes "hot" and, since grounded wires are in this circuit, wires from the terminal provide a ground to the industrial timer as well as the solenoid. The solenoid is therefore engaged during the period that the industrial timer is actually running.

The instant the industrial timer mechanism expires, terminal NC loses power and terminal NO receives power. This cuts the current to the solenoid

while providing current to the motiondiser. The instant the solenoid snaps back, therefore, the turntable begins to rotate.

After the turntable starts to turn, the microswitch nearest the solenoid is thrown; this breaks the ground in the timing circuits of both the 132 timer as well as the center 112 timer. The breaking of the ground to the middle 112 timer cuts off terminal 7 of this timer and therefore shuts off the industrial timer. This shutting off of the industrial timer eliminates terminal NO as the source of power to the motiondiser. The motiondiser must receive power from another source at this time, therefore, and this is provided by terminal 1 of the 132 timer. This terminal gets power at the same instant that terminal NO of the industrial timer loses its power.

When the motiondiser advances the turntable far enough that the microswitch is rethrown, it loses its power, because at this instant, the 132 timer circuit is reactivated and terminal 1 of this timer subsequently loses power. At the same time, the middle 112 timer regains power and all three Paragon timers are therefore running again at this point.

If the timers are set correctly, the outer 112 timer expires shortly after the first sample is taken. Upon expiration, its terminal 6 loses power, and therefore,cuts power off to the center 112 timer. The outer 112 timer receives its power directly from the inlet and will not be reset until the entire mechanism is shut off and turned on again; the two 112 timers are, therefore, permanently out of the circuit from this point on.

The same basic cycle covered above is now repeated over and over again, until all 24 bottles are filled. The only difference is that the industrial timer and solenoid are engaged through terminal 7 of the 132 timer, instead

of terminal 7 of the 112 timer. After the 24th sample has been taken, the microswitch on the inlet line is thrown and the entire system loses its power.

River and Beach Monitoring of Storm Water Overflows

Purpose

Results from samples taken prior to this special survey indicated that the direct discharge of overloaded combined sewers to the river had a definite effect on the quality of the water in the river. It was desired, therefore, that more information about the water quality in the river be obtained before and after overflows had occurred. To achieve this, a separate river-monitoring program of storm water overflows was set up as outlined below.

Method

In order to obtain a sound comparison, it was desired that the river be sampled before the overflows occurred, preferably within the 24-hour period preceding an overflow. To do this, arrangements were made with the Weather Bureau at the Naval Air Station, in which the bureau was to notify Project personnel at least [illegible] hours before a rainfall with an intensity greater than 0.1 inches per hour was to arrive in the area. Upon receipt of this notification, Project personnel were to immediately go out and sample the river, regardless of the time of day, at points which would give a general picture of the river quality. After a significant rain had passed through the area, the river was sampled again as many times as it was deemed

necessary, or conditions permitted, or until the effect of the storm upon the water had subsided.

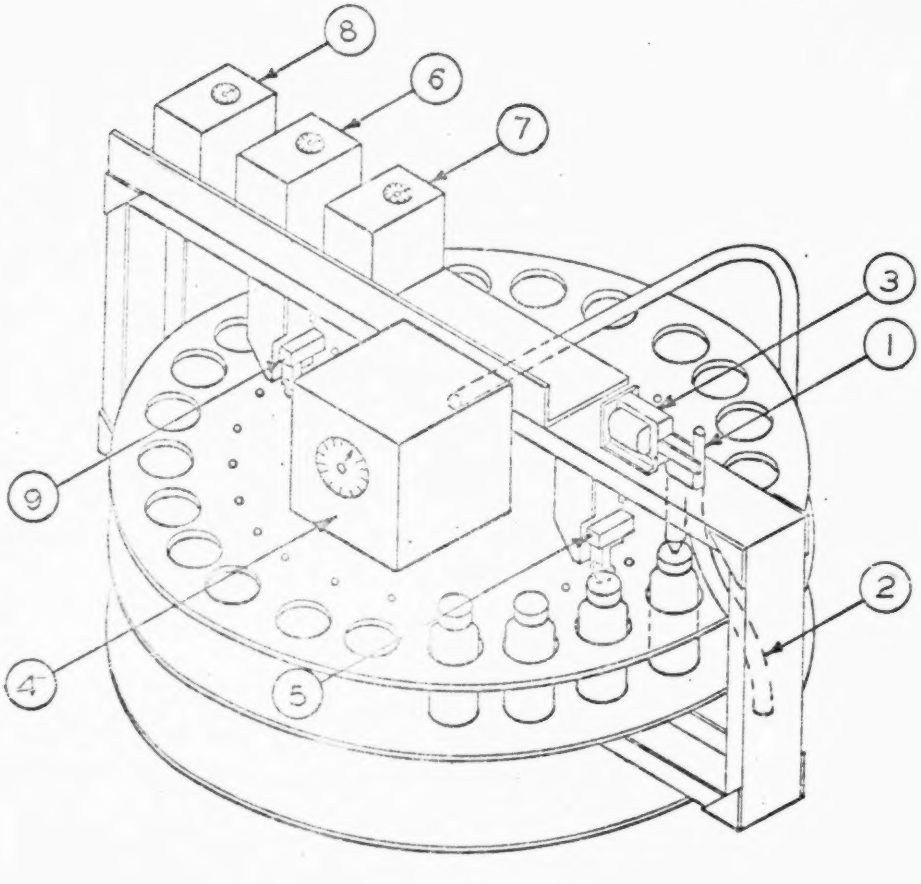
Equipment

Sampling was done from one of the Project boats and no unusual equipment was required.

Location

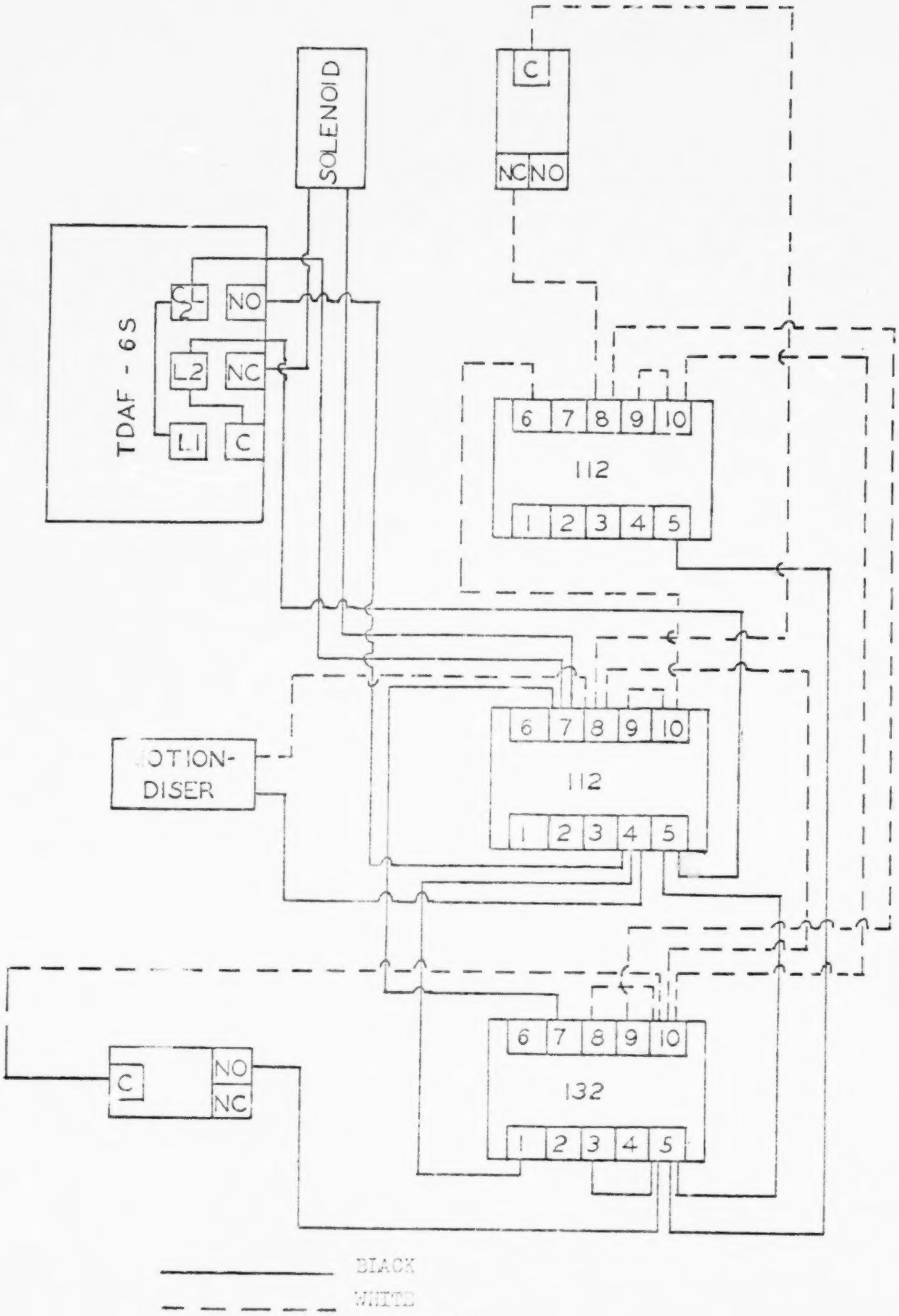
Three stations were selected on Range DT 30.8W to show the quality of the water entering the river; three stations were selected on Range DT 28.4W to show the effect, if any, of the effluent from Conners Creek, and five stations were also sampled at DT 20.6 which is located below most of the Detroit outfalls on the river. Three stations were also sampled at DT 14.6, which is located below the Rouge River as well as Ecorse Creek, and three stations were also sampled on DT 3.9, which is located at the mouth of the Detroit River.

AUTOMATIC SAMPLER USED IN STORM WATER OVERFLOW STUDY
DETROIT RIVER–LAKE ERIE PROJECT

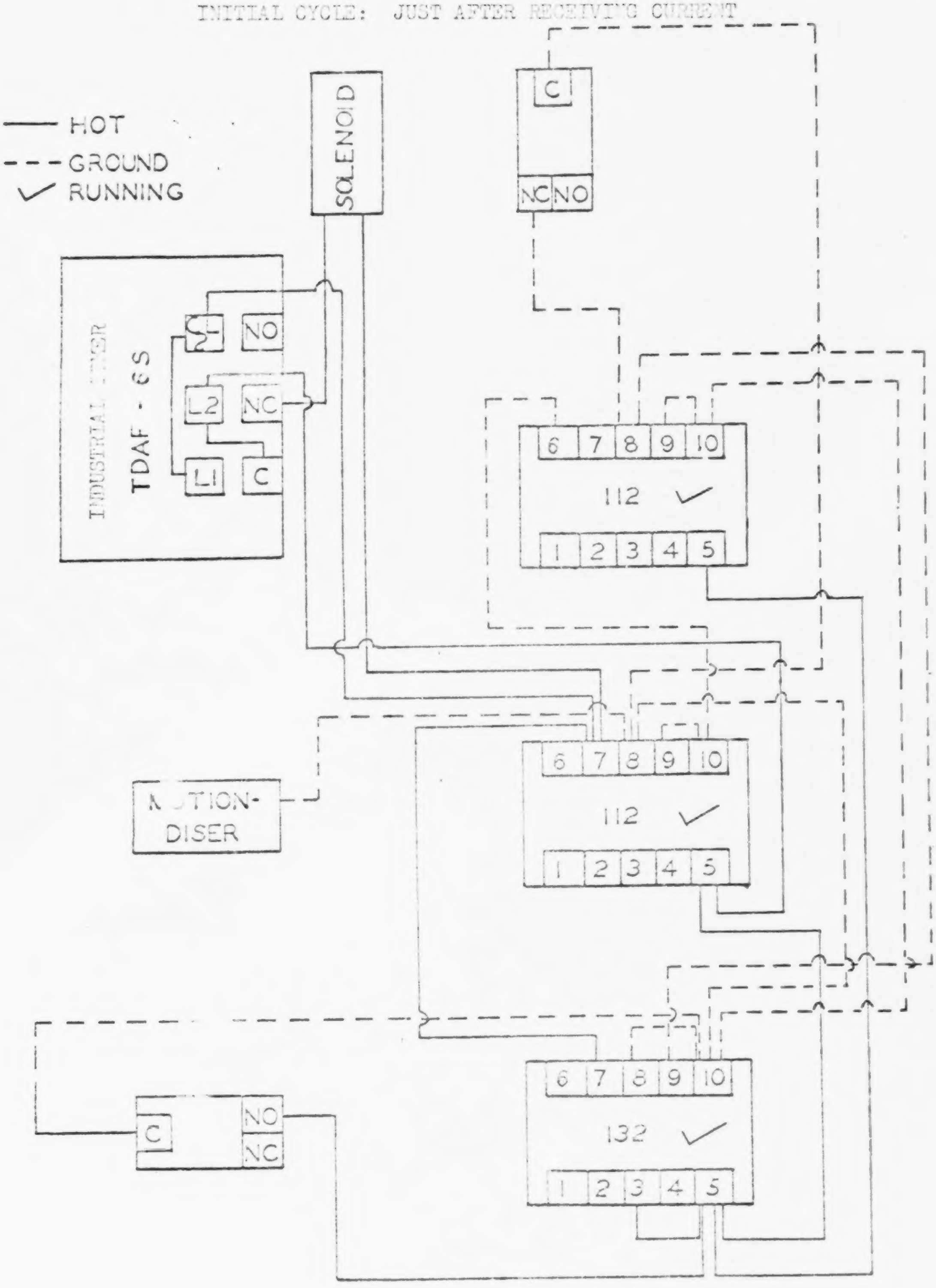


PREPARED BY PUBLIC HEALTH SERVICE

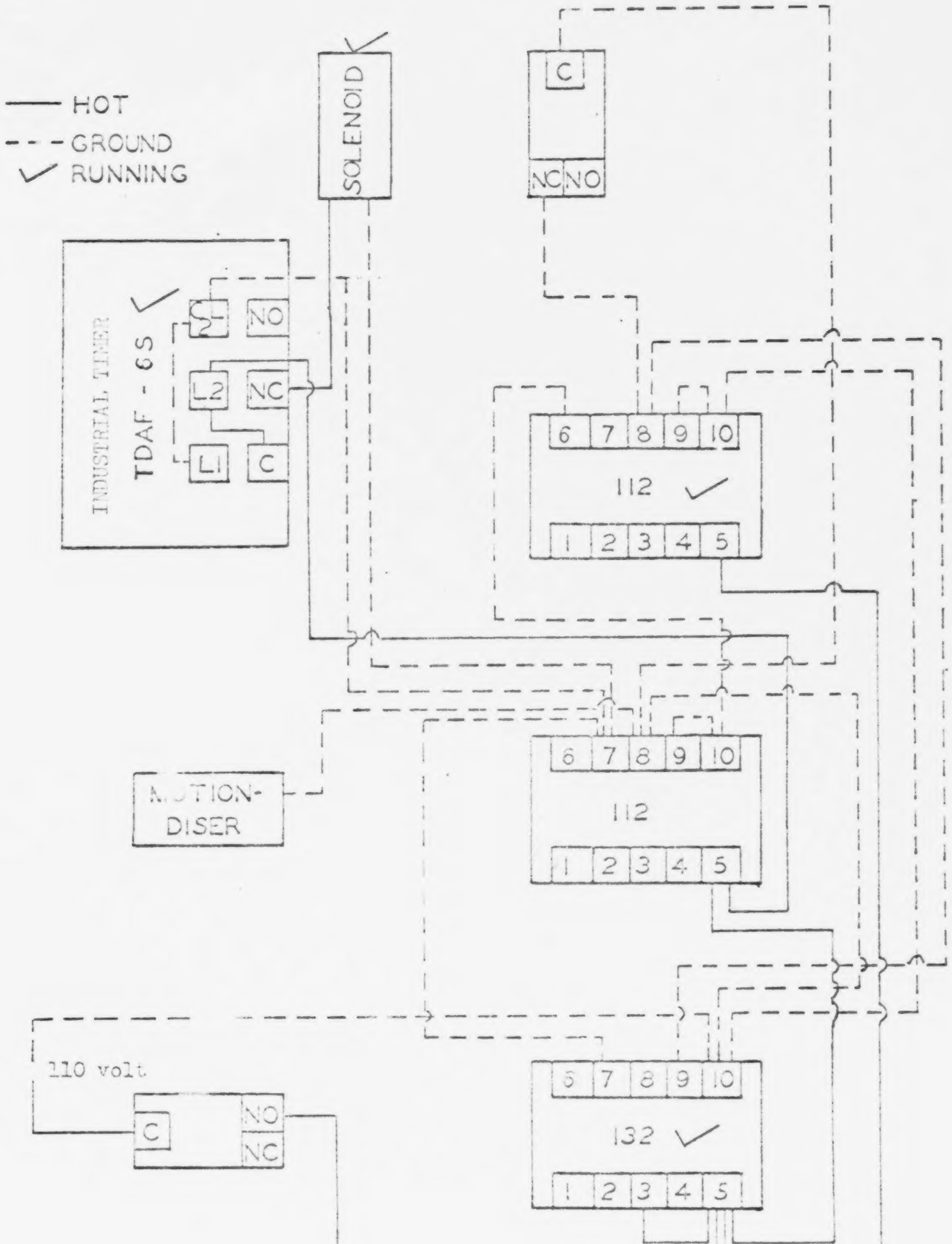
NEW ELECTRICAL DESIGN 1/14/6[illegible]



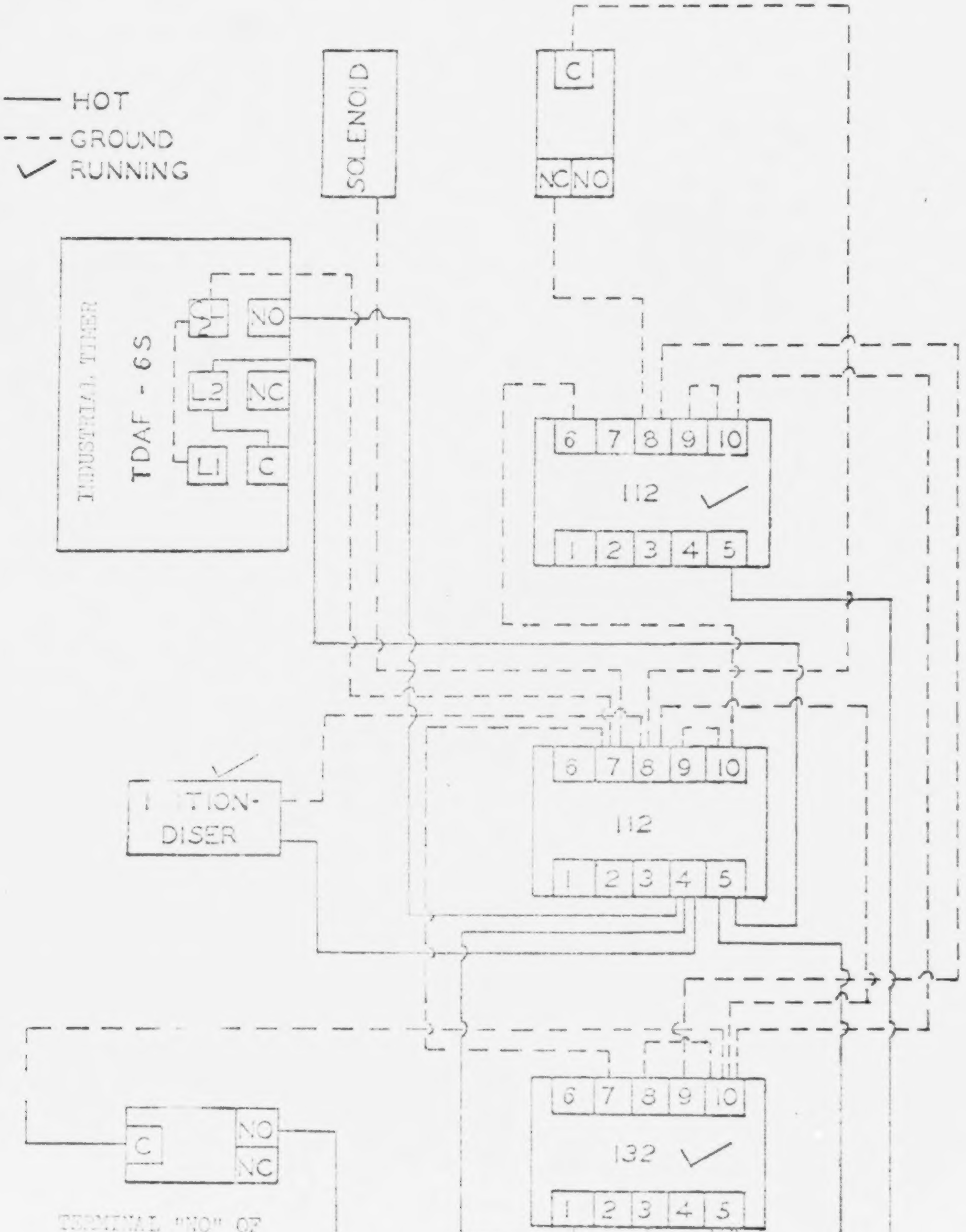
INITIAL CYCLE: JUST AFTER RECEIVING CURRENT



INITIAL CYCLE: JUST AFTER THE MODEL 112
TIMER HAS EXPIRED: (SOLENOID ENGAGED)

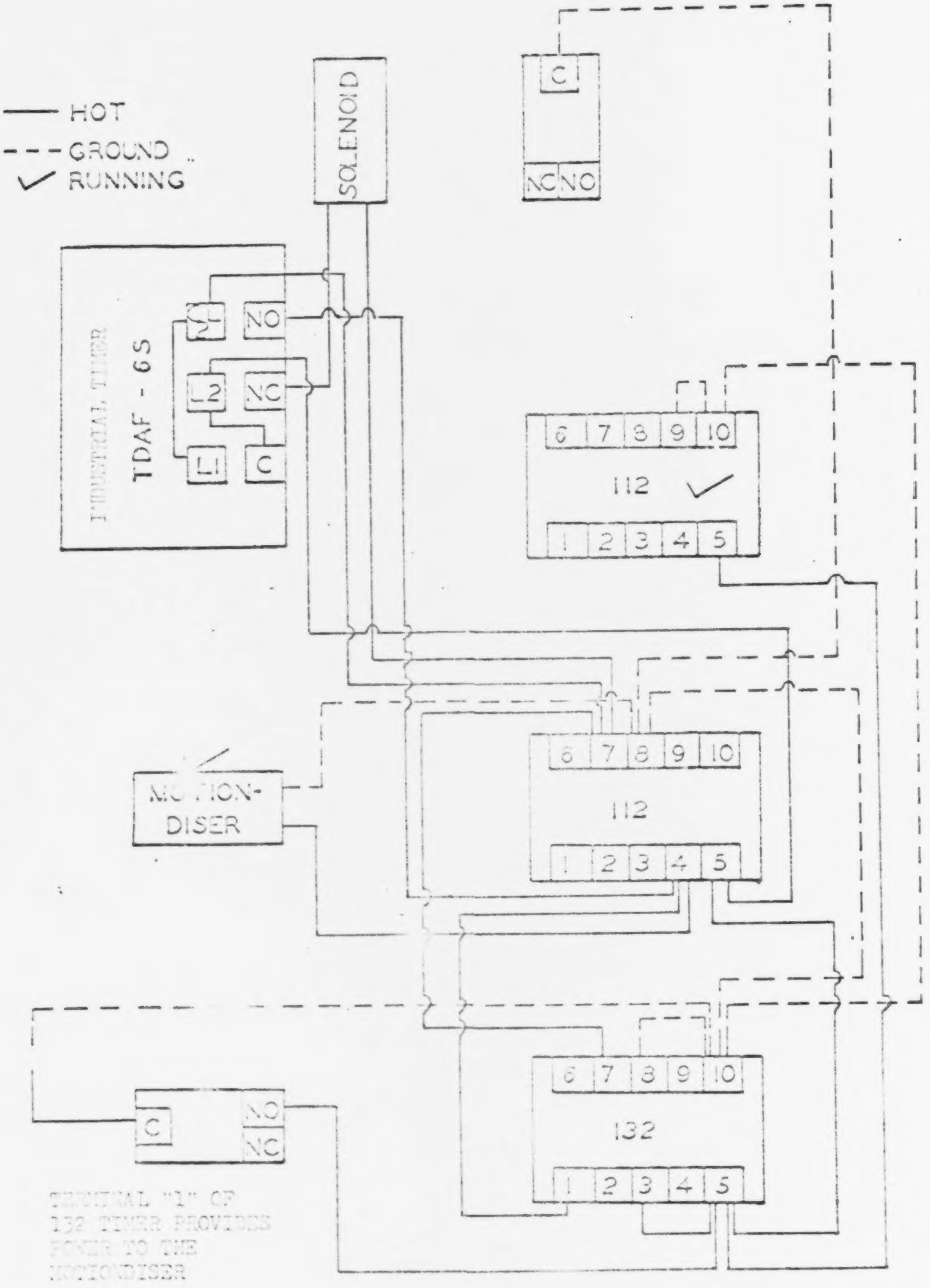


INITIAL CYCLE: MOTIONDISER ENGAGED
MICROSWITCH NOT YET THROWN

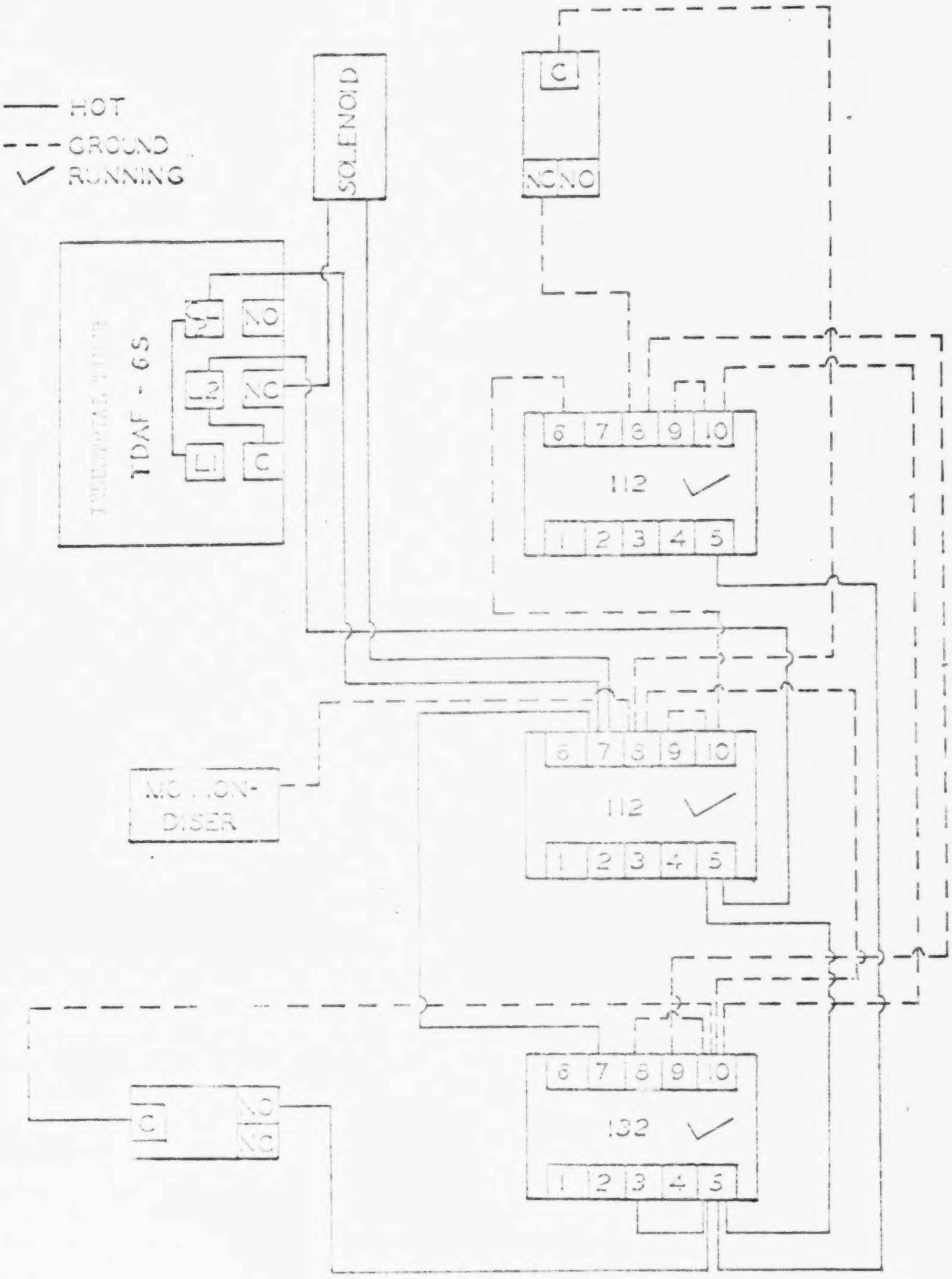


TERMINAL "NO" OF
INDUSTRIAL TIMER
PROVIDES POWER TO
MOTIONDISER

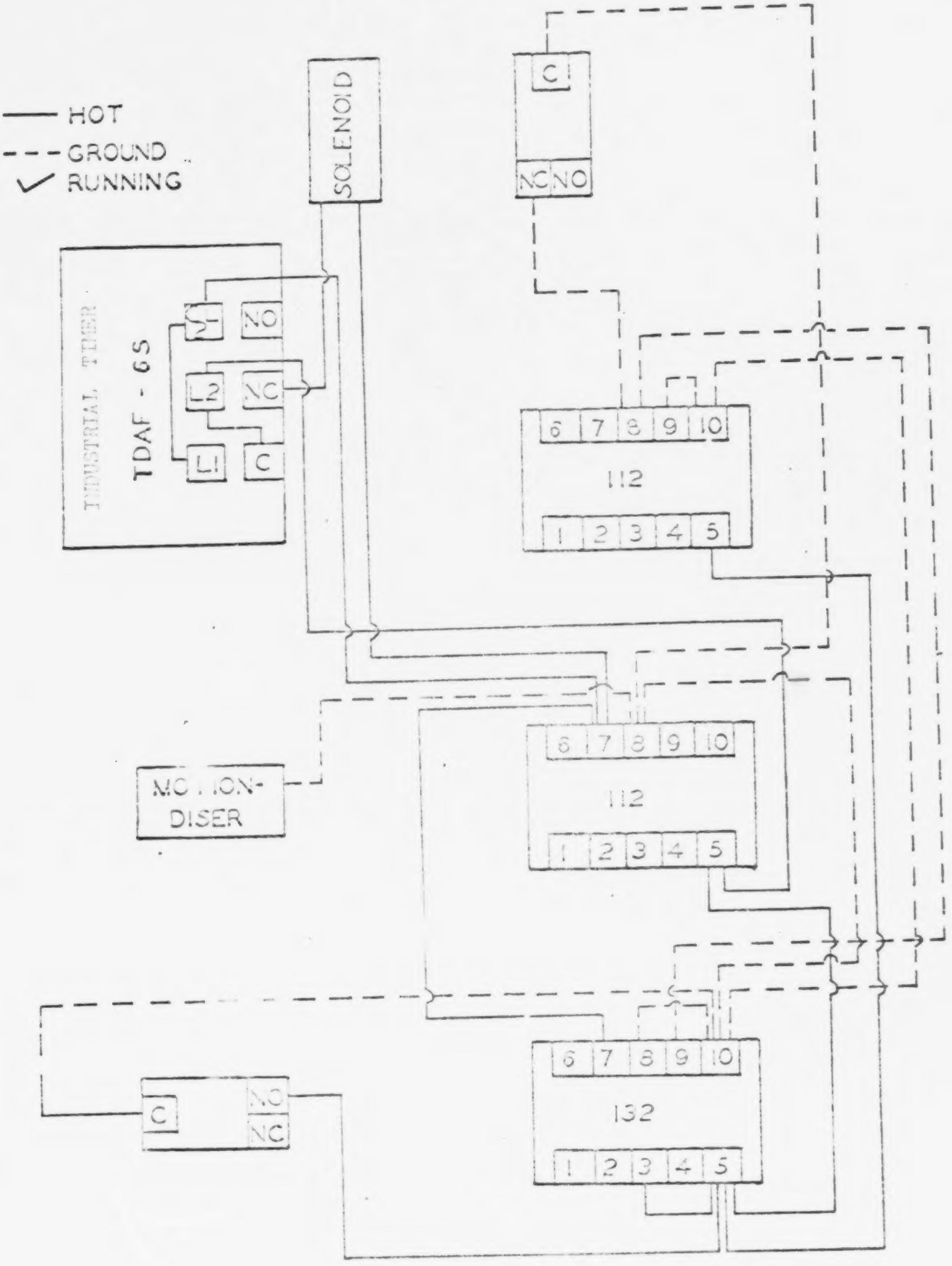
[illegible]: MOTIONDISER ENGAG[illegible]
MICROSWITCH THROWN

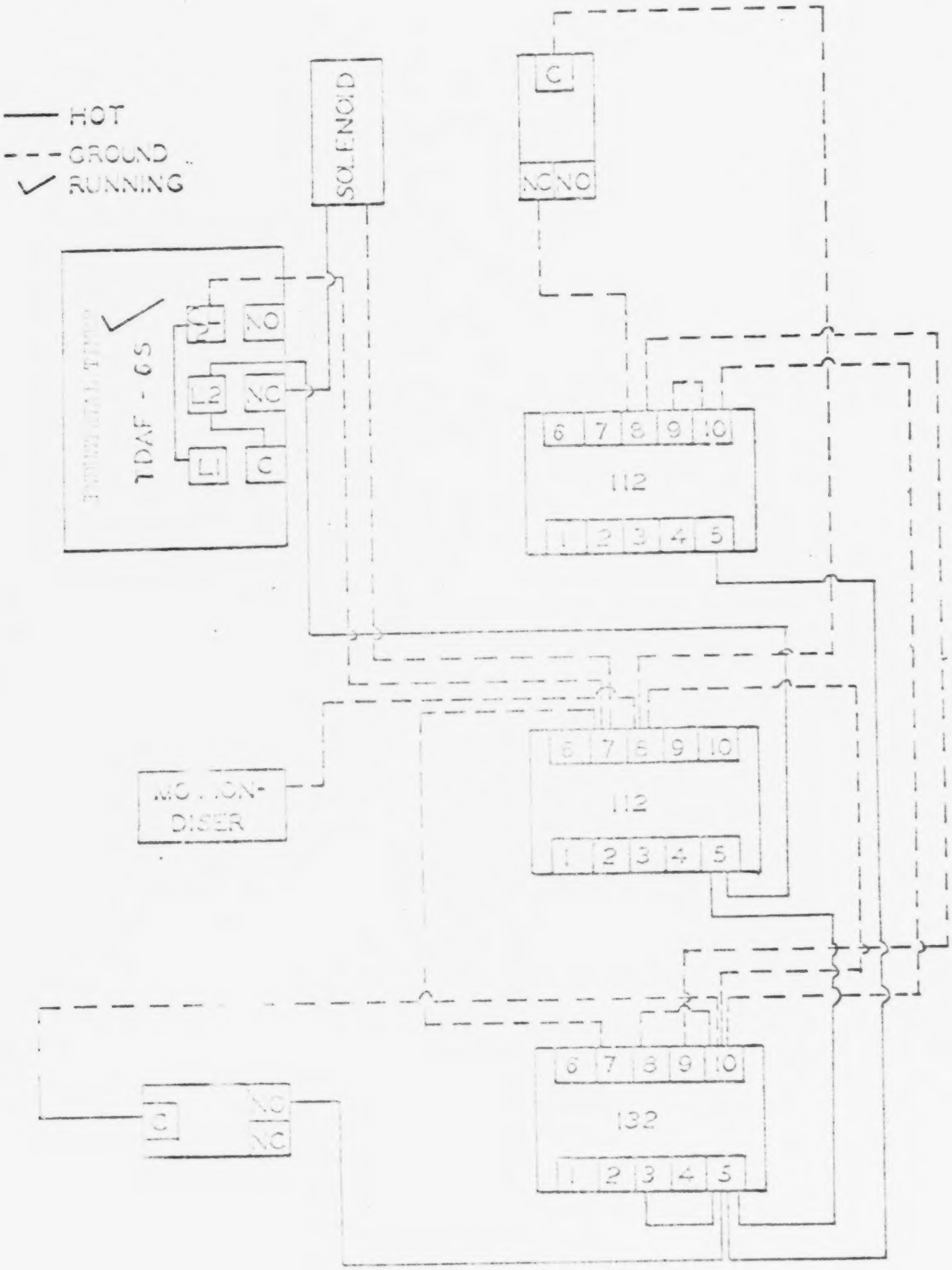


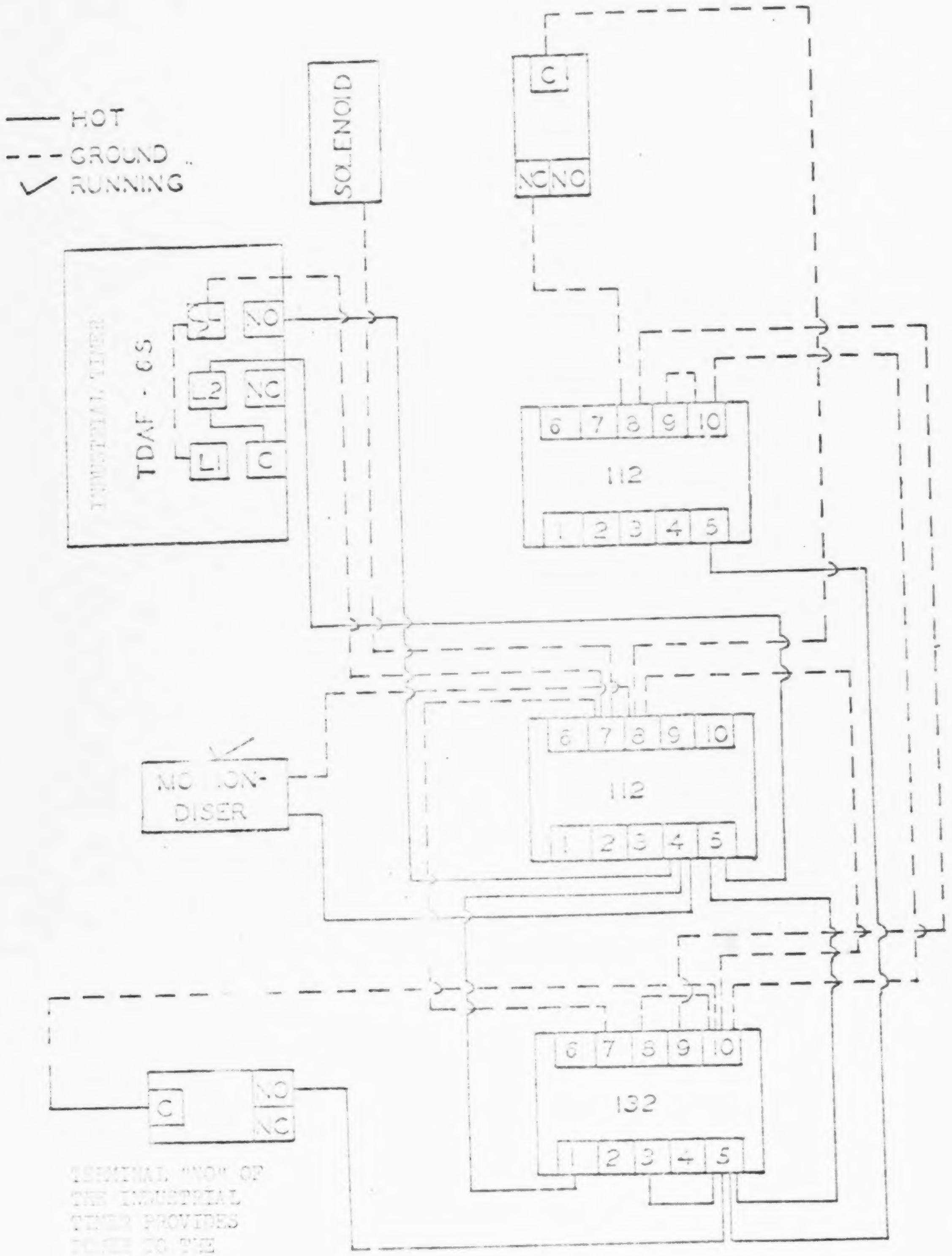
[illegible]: JUST BEFORE UPPER [illegible] TIMER EXPIRES



[illegible] CYCLE: JUST AFTER UPPER 112
TIMER EXPIRED

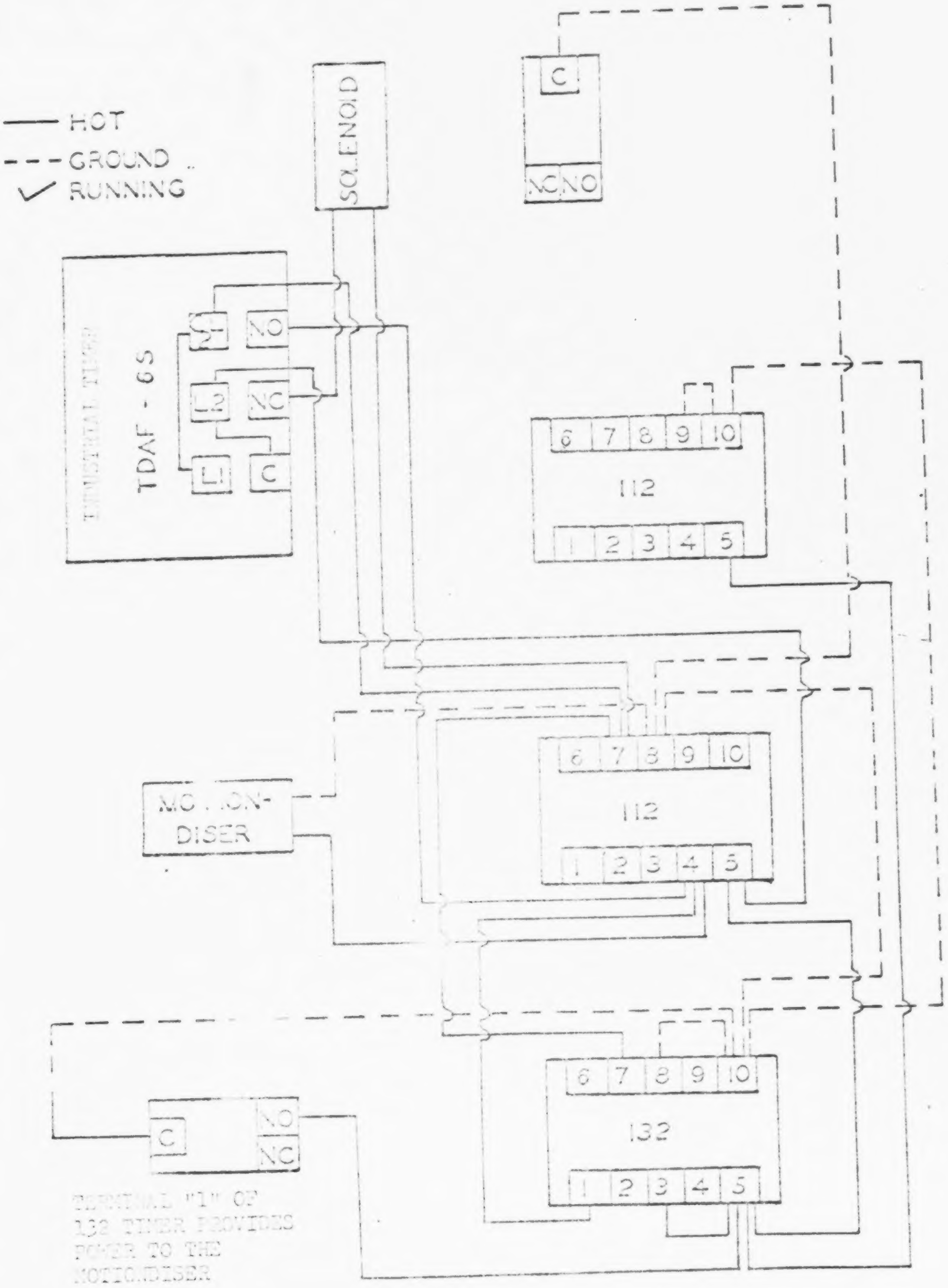



HOT
GROUND
RUNNING
SOLENOID
C
NC NO
TDAF - 65
NO
L2
NC
L1
C
6 7 8 9 10
112
1 2 3 4 5
MOTION-
DISER
6 7 8 9 10
112
1 2 3 4 5
6 7 8 9 10
132
1 2 3 4 5
C
NO
NC



TERMINAL "NO" OF THE INDUSTRIAL TIMER PROVIDES POWER TO THE MOTIONDISER.

NORMAL MODE 4: MOTIONDISER ENGAGE
SWITCH THROWN



BIOLOGICAL STUDIES

Introduction

The procedures followed in the biological studies were standardized with those employed by the Public Health Service, Great Lakes-Illinois River Basins Project. With minor variations, the same procedures are also used by the U.S. Bureau of Commercial Fisheries and the University Institutes engaged in studies of the Great Lakes.

Descriptions and figures of most of the pieces of apparatus mentioned in this summary of operations are provided in "Standard Methods for the Examination of Water and Wastewater" (11th edition) and in Welch's "Limnological Methods." Details of methodology are also covered in these treatises.

To assure adherence to standard practice, all personnel cooperating in the biological work were trained by the Project biologist. The usual precautions were taken, of course, to label sample containers and specimen jars with the station location and date of collection. In the field, this was done with a china-marking crayon. In the laboratory, collection identification labels were placed in the preserving fluid of the jars and vials into which specimens were sorted. The catalogued collections of preserved material are available for reference.

The 31-foot boat was used for the survey work. Operations were carried out by a team composed of the boat operator, two engineers, two aquatic samplers, and the biologist. When the biologist was not aboard, responsibility for proper collection and handling of the biological samples was delegated to the engineer in charge of the survey.

Bottom-fauna Sampling and Processing

To obtain information on the distribution and abundance of benthic invertebrates, 53 key stations were selected for sampling: 28 located on critical ranges of the Detroit River and 25 located in the Michigan waters of Lake Erie. These bottom-fauna stations were selected on the basis of reconnaissance surveys conducted during the 1962 season. (For lake station numbers and locations, see map, Figure 26.)

Depths at the stations on the river ranges vary from a minimum of 4 feet at the American shore to a maximum of 43 feet in the channel at the international boundary lines. The majority of the river stations are located at depths of from 20 to 30 feet. Most of the lake stations are between 20 and 25 feet in depth; the maximum depth as shown on the U.S. Lake Survey chart is 26 feet, the minimum 5 feet.

Three bottom-fauna surveys were conducted during the 1963 season: one at the end of May, one the last week in August, and one the third week of October. All the stations were sampled during the spring and autumn surveys. In the August survey, only the river stations were sampled.

While the boat was anchored for bottom-fauna dredging, the following meteorological and hydrological measurements were made: wind velocity and direction, wave height and direction, current velocity and direction, sky cover, air temperature, resistance-thermometer profiles, and Secchi-disc transparency readings. (See field data sheets for record of complete measurements and observations; for description of Secchi disc and method of making measurements, see Welch (1), pp. 159-160.)

Water samples for chemical determinations of pH, alkalinity, dissolved oxygen, nitrates and phosphates were also taken at selected stations. On the river, samples were taken at the surface only. On the lake, one sample at the surface and one near the bottom were taken for dissolved oxygen determinations at all stations. A surface sample for pH and alkalinity determinations was taken at all stations. Nitrate and phosphate determinations were limited to surface samples taken at the 12 stations where phytoplankton collections were made periodically. Sampling for phytoplankton and zooplankton, as described below, was also done while the boat was at anchor for bottom-fauna dredging.

A hand-operated winch, equipped with metering wheel and wire cable, was used to lift the dredge. All samples from the bottom were taken by a Petersen dredge with weights attached to bring its total weight to 70 pounds, unloaded. With jaws fully open, it bites into an area of bottom approximately 0.9 square foot. (For detailed description of Petersen dredge construction, maintenance and operation, see Welch (1), pp. 17[illegible]-180 and "Standard Methods" (2), pp. 574-575.)

Principal steps in handling the bottom-fauna samples follow:

1. Three dredge hauls are taken at a station.* Contents of the dredge are discharged into a heavy-duty metal pan, then dumped into a large plastic dishpan. Material from each haul is worked up separately so that averages of

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*Because of prolonged bad weather during the spring survey, only one haul for bottom fauna was taken at each of the soft-bottom lake stations. During this survey, an extra haul for bottom material analysis was collected at the lake and river stations.

the numbers of various groups of organisms can be used in calculating the numbers per square foot of bottom at each station.

2. The sample obtained from a haul is washed by gently hosing it through a set of two rectangular utility screens. The top one for coarse material is ¼-inch galvanized hardware screen; the bottom one is No. 30 brass screen. These are nested on a waist-high table rigged on the rail of the vessel so that the water is sluiced overboard.*

3. Preliminary picking and sorting of the collections are done on board ship. The larger snails, clams, and leeches are picked out during the hosing operations. The rest of the material from the No. 30 screen is washed into a white enamelled pan for tweezer picking and sorting. Some samples require additional screening. This is done with a No. 30 U.S. standard sieve, using a bucket of water and a turkey baster.

4. All specimens are sorted into screw-cap plastic jars containing collection water, and they are stored in an ice chest. Stones covered with colonies of organisms are submerged in galvanized buckets for examination at the laboratory. Occasionally, under foul weather conditions, a few dredge hauls are brought back in the plastic dishpans to be sieved at the laboratory.

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*A slight variation in this method was employed during a follow-up survey of selected river and lake stations conducted during the week of August 10, 1964. All the samples were taken from soft bottom. The 25-foot boat, used for this survey, was not equipped with a hose pump. Mud, silt, and ooze were removed from each dredge haul by dumping the dishpan into a 28 mesh nylon bag, which was stitched to a 20-inch diameter canvas collar, grasping the collar securely, and dunking the bag in the water. (The Tyler equivalent for the No. 30 U.S. Standard Sieve is 28 mesh: check of losses with a 32 mesh nylon bag disclosed that escape of tubificid worms from the 28 mesh nylon was negligible.) Washed samples from the bag were sieved through a set of No. 5, No. 10, and No. 30 U.S. Standard Sieves in a wide-mouth bucket, using water dipped by ship's bucket while at anchor.

5. Samples are brought to the laboratory the same day they are collected and are held in a refrigerator at about 7° C. Each haul is processed into proper preservatives for the various types of organisms. (Formalin, 10 percent, is most commonly used.) The specimen jars are labelled, and the collection record is completed. Wherever feasible, identifications are made to species from the living animals. Total counts are made of the number of each taxonomic grouping.

6. Numbers of worms in the large tubificid aggregations are estimated by the water displacement method. Care must be taken to free the aggregation from all foreign material by repeated floatation, washing, and screening. Fluid from the cleaned sample is removed by draining and blotting. Worms are separated from an aliquot of the sample with jewelers tweezers, and a number counted sufficient to displace 1-ml of tap water contained in a 25-ml graduated cylinder. Displacement of the total sample is measured in a 500-ml graduated cylinder, and the total number of worms in the sample is calculated.*

7. Relative abundance of periphytic organisms, such as sponges and bryozoans, which colonize stones is expressed as "sparse," "medium," or "dense."

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*The modified floatation method developed by Anderson (3) was used to remove tubificid worms from the 1964 bottom samples. These had been preserved in 10 percent formalin, so the floatation time was five minutes or less: bits of bottom debris which were floated by the sugar solution along with the worms also interferred with the procedure. In arriving at quantitative estimates, the number of preserved worms obtained by repeated floatations was multiplied by 2 (the factor derived by Anderson for efficiency of floatation of tubificid worms removed from bottom samples before and after preservation by using a solution of granulated sugar with a specific gravity of 1.12).

3. A complete record for each collection is kept by station on field data sheets and laboratory bench sheets. Data is collated on needle sort punch cards. The catalogued collection of preserved specimens is maintained in the laboratory for reference.

Phytoplankton

Surface samples for determining the distribution and abundance of planktonic algae were collected at approximately three-week intervals. Thirty-five stations were selected: 23 on ranges of the river, 12 in critical areas of the lake.

Samples from near the bottom were collected only at selected stations during the bottom-fauna cruises mentioned above since depth sampling studies had indicated that the waters were homothermous and well-mixed vertically. After the boats were laid up, phytoplankton collections were limited to samples taken from the Belle Isle bridge and the two Grosse Ile bridges.

Phytoplankton sampling runs were made during the day, using the 25-foot boat. Usually the river stations were sampled on one day, and the lake stations the following day.

Collections were made from just below the surface with a Kemmerer sampler (capacity, 3 liters): description and instructions for operation and maintenance are given in Welch (1), pp. 192-201, 231.

The raw water sample was run into a two-liter polyethylene bottle containing approximately 70 ml of phytoplankton preservative (thimerosal - 0.16 percent, Lugol's solution - 1.0 percent, plus one gram of sodium borate for each gram of thimerosal; for effectiveness of this preservation, see Williams (4).

Care was exercised to take the samples with the Kemmerer sampler in a vertical position and to keep the sample bottles out of direct sunlight. Air and water temperatures were recorded at time of collection.

The methods employed in the laboratory for processing and analyzing the phytoplankton samples followed closely procedures developed by the Public Health Service in its National Water Quality Network plankton studies. A critical discussion of these methods is given by Williams (4). For description of equipment and discussion of techniques employed in plankton analysis, refer to Welch (1), pp. 279-297, also "Standard Methods"(2), pp. 543-572.

Identification and Enumeration of Algae by Sedgwick-Rafter Slide Strip Count Technique

The following covers the sequence of operations as performed in our laboratory from the 2-liter preserved sample:

1. The sample is thoroughly mixed by inverting the bottle, swirling the contents, and then gently rocking it lengthwise.

2. An aliquot of about 250 ml is poured at once into a beaker and transferred to a polyethelene bottle of a size to fit the hand conveniently for remixing.

3. The Sedgwick-Rafter counting slide is immediately loaded with a straight-tip dropping pipette (polypropylene, 2 ml capacity, 110 mm in length, with orifice of about 1 mm).

4. Two strip counts are made under 200 diameters magnification by moving the slide lengthwise with the mechanical stage of the microscope and enumerating those specimens which are enclosed in the area of the Whipple ocular micrometer. The minute centric and pennate diatoms are simply tallied by

groups since they cannot be identified to genus under magnifications obtainable with Sedgwick-Rafter slide.

The colonial diatoms *Melosira*, *Asterionelle*, *Fragilaria*, and *Tabellaria*, can be recognized to genus, however. Algae belonging to other groups can be determined to genus, some to species. Each single-celled individual or natural colony is counted as one unit.

5. Counts for each genus and group of algae are recorded on the bench sheet, tallying counts obtained in each strip separately. Counts of inert diatoms or other specimens which were not in the living state at time of collection are also tallied.

6. Quantitative expressions of the number of phytoplankters per ml are derived by applying the factor of 25, which was obtained from calibration of the microscope, micrometer, and slide.

Membrane Filter Preparations

1. A metal millipore filter holder is mounted into a 2-liter sidearm flask attached by heavy rubber tubing to a vacuum outlet. This is the same setup used for bacteriological membrane filter operations. Sterile technique is not required for plankton work. However, membrane filters must be kept free of dust, and the filter funnel must be rinsed with tap water and wiped after each operation.

2. A membrane filter is positioned in the filter holder, using tweezers to handle the filter. (Type of filter used is millipore; plain, 0.45 micron pore size, 47 mm diameter.)

3. The vacuum is turned on, and a 250 ml aliquot of the mixed sample is poured into the funnel.

4. The vacuum is turned off as soon as filtration is completed, and the filter is removed from the holder with tweezers.

5. The filter is labelled in the free margin immediately upon removal from the holder. Station number, date of collection, and the size of aliquot are recorded in waterproof ink.

6. Filters are dried in a covered tray and stored in screw-cap vials.

The membrane filter preparation serves as an herbarium record of most of the phytoplankters. For diatom identification and enumeration, the filter can be mounted in cedarwood oil or immersion oil. If preferred, a permanent hyrax slide can be made by the method described below, after dissolving the filter in acetone and decanting the excess fluid. A comprehensive discussion and bibliography covering the application of membrane filter techniques to studies of the phytoplankton are contained in a paper by C. D. McNabb (5).

Vial Concentrates from Settled Plankton

1. The sample remaining in the bottle is thoroughly mixed, and excess sample down to one liter is discarded.

2. The remaining one liter of the sample is then settled for about 24 hours. This is done in the inverted sample bottle which is stoppered with siphoning tubes, adjusted so approximately 200 ml of the concentrated sample can be retained. (A set of 12 bottles are inverted in racks hung over the sink.)

3. Excess fluid is run off into the sink by releasing the clamp on the outlet tubing.

4. The vacuum is turned off as soon as filtration is completed, and the filter is removed from the holder with tweezers.

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3. Excess fluid is run off into the sink by releasing the clamp on the outlet tubing.

4. The stopper is removed, and the concentrated sample is poured into a 250 ml beaker labelled with station number and collection date. Beaker is covered and left undisturbed for about 24 hours. (Siphon tubes and sample bottles are rinsed with tap water and drained.)

5. Fluid is removed from the beaker with a syringe so that approximately 40 ml of the concentrated sample remains. (The pipette of the syringe must be lowered gradually into the fluid and the inflow into the syringe bulb controlled so that none of the settled plankton is disturbed.)

6. The 40 ml concentrate, which represents the settled plankton from one liter of the preserved sample, is stored in a 45 ml screw-cap vial in which a permanent identification label has been placed.

Vial concentrates, when properly catalogued and maintained, provide a collection of valuable material for critical qualitative and quantative studies of nannoplankton. The vials need to be checked periodically for replenishment of preserv[illegible]ive.

Preparation of Hyrax Slides for Diatom Identification and Enumeration

1. The plankton concent[illegible] from one liter of the sample is used in preparing the [illegible] slides. Materials required are: hyrax liquid mounting medium (refractive index 1.65), benzene, 18 mm cover glasses (No. 1, square), non-corrosive microscope slides.

2. A set of a dozen slides at a time are produced. Care must be taken to arrange the vials, cover glasses, and slides in a matched sequence. Station numbers and collection dates are inscribed on the slides with a

diamond marker.

3. The series of cover glasses is set up on an electric hot plate adjustable for temperatures up to 600° F.

4. Each cover glass is loaded with 16 to 20 drops of the mixed concentrate delivered from a glass dropping pipette of suitable aperture.

5. Fluid is evaporated from the cover glasses very gradually by setting the hot plate at low heat.

6. Residue on the cover glasses is incinerated on a red-hot plate for an hour.

7. The cover-glass preparation is affixed to the slide by grasping it with tweezers and inverting it onto a drop of hyrax mounting medium placed in the center of the slide.

8. The slide is placed on the hot plate (at about 200° F.) to evaporate the mounting medium.

9. The slide is removed from the hot plate to a masonite mounting board where the cover glass is centered before the medium hardens.

10. Excess medium is scraped from the slides with a razor blade, and slides are cleaned with benzene. Finished slides are stored in a slide box, arranged by station and date sequence.

11. Identification and proportional counting of the diatoms are done from the hyrax slide under oil immersion at 1212.5 diameters, using Koehler illumination. About 250 individuals are counted to determine the four most abundant species. The percent occurrence of each species in the sample is then applied to the diatom group total derived from the Sedgwick-Rafter strip counts to obtain an expression in numbers per milliliter. (See the monograph

by Williams (4) for a discussion of proportional counting.)

Zooplankton

To obtain data on the occurrence and relative abundance of the planktonic microcrustaceans, rotifers, and protozoans, collections of net plankton were made at the phytoplankton sampling stations during the spring and autumn bottom-fauna surveys.

Zooplankton sampling was done with a one-half meter oceanographic net (No. 20 nylon) equipped with a weighted plankton bucket.

Samples were taken by vertical tows, one tow at each station. The net was lowered through the water until the weights attached to the bucket almost touched the bottom. It was towed to the surface by hauling in the line slowly at a uniform speed of about one foot per second. The ring of the net was quickly raised from the surface of the water, and the sleeve was rinsed by repeated immersions. The bucket containing the collection was detached from the net, and the contents were drained into a polyethylene bottle. Clinging plankters were removed from the bucket by squirting preservative from a syringe. Ninety-five percent ethyl alcohol was used to kill and preserve the zooplankters. The net concentrate was brought up to a volume of 100 ml with the preservative.

Enumeration was done under a widefield stereoscopic microscope at 120X magnification from two 1-ml aliquots of the concentrate contained in a Sedgwick-Rafter counting cell. A survey count by groups of microinvertebrates was made, i.e., all copepods and nauplii, cladocerans, and rotifers were enumerated. Protozoans were not included. The mean of the two counts was

used to compute the number of organisms per liter. Whenever a pair of counts showed marked deviation from the mean, one or more additional aliquots were counted.

The number of organisms per liter in each group of animals was roughly calculated by applying concentrate and depth factors to the survey count totals.

The net strains a column of water the area of the 0.5 meter ring. For vertical tows with this net, the simplified conversion formula applied was $n/l = 1.7 \frac{N}{D-5}$ where N equals the mean of the paired counts, D equals sounded depth in feet, 5 equals height in feet of net ring when weights are touching bottom. No efficiency factor for the net was derived since it is recognized that the quantitative data can be used only for rough estimates of relative abundance. (See Langford (6) for a critical discussion of zooplankton sampling methods.)

Periphyton

Collections of periphytic organisms, such as hydras, bryozoans, sessile protozoans, algae, fungi, and sheathed bacteria, were obtained by suspending sets of microscope slides contained in racks from U.S. Coast Guard buoys on the river located near ranges DT 30.3, DT 17.0, and DT 8.7.

A rectangular rack was built to hold a set of 16 microscope slides. It was made from strips of cypress wood with bottom and hinged lid of hardware screen according to the general design given in Welch's "Limnological Methods," pp. 260-262. The 18 saw-cuts in the long pieces of frame were made wide enough to hold two slides in the slot instead of a single slide.

Because of strong currents and boat traffic in the river, it was necessary that the racks tied off the buoys should float horizontally at a depth of three feet. Each rack, accordingly, was fitted with a current baffle at the end where the retrieving line was to be fastened and with a float at the other end. The baffle was made from a piece of sheet metal 3 inches wide bent around the frame end at a 60-degree angle to form fins about 4 inches long. For the float, a toilet bulb was bolted to a piece of sheet metal cut at a right angle to cover the butt end of the frame. Both pieces were slotted and attached with bolts and wing nuts to the frame so that they could be demounted when the rack was lifted from the water at collection time. The rack was counter-balanced with lead weights attached to the bottom of the frame so that it would float out horizontally from the buoy in the current at the desired depth. A length of heavy-duty sash chain was affixed to the padeye of the buoy to serve as a retrieving line, and the rack was attached by clipping the snap fastener at the end of the chain to an eyebolt centered in the frame end at the baffle. During the summer season, a lush growth of periphytic organisms populated the slides within a submergence period of two weeks.

Four collections were made from the slide racks during the season. A summary of the method of handling the collection follows.

The retrieving line at the buoy is picked up with a boat hook, and the rack is quickly unclipped from the snap fastener. The baffle and float attachments are demounted, and the rack is wrapped in aluminum foil. Racks are covered with collection water in separate trays which are nested in an iced refrigerator chest.

Collections are worked up in the laboratory the afternoon and evening of the collection day in the following manner. The three sets of slides from the middle of the rack are preserved in screw-cap jars: one set in 10 percent formalin for reference, the two adjacent sets for nitric acid treatment and diatom hyraz mount preparations. Every other set of the remaining slides is examined for living organisms, which grow attached to the outside surfaces of slides. Each of these eight sets is placed, clean sides down, in a petri dish lid containing enough water for the tray to cover them. The slides are inspected under a widefield stereoscopic microscope providing magnifications up to 120 diameters. The density of the various kinds of organisms found on the slides from each rack is expressed qualitatively on a scale of relative abundance. Clean sets of slides are placed in the vacant slots of the rack. Racks are held submerged in the water of the tray in the chest refrigerator to be reset at their respective buoys the next day.

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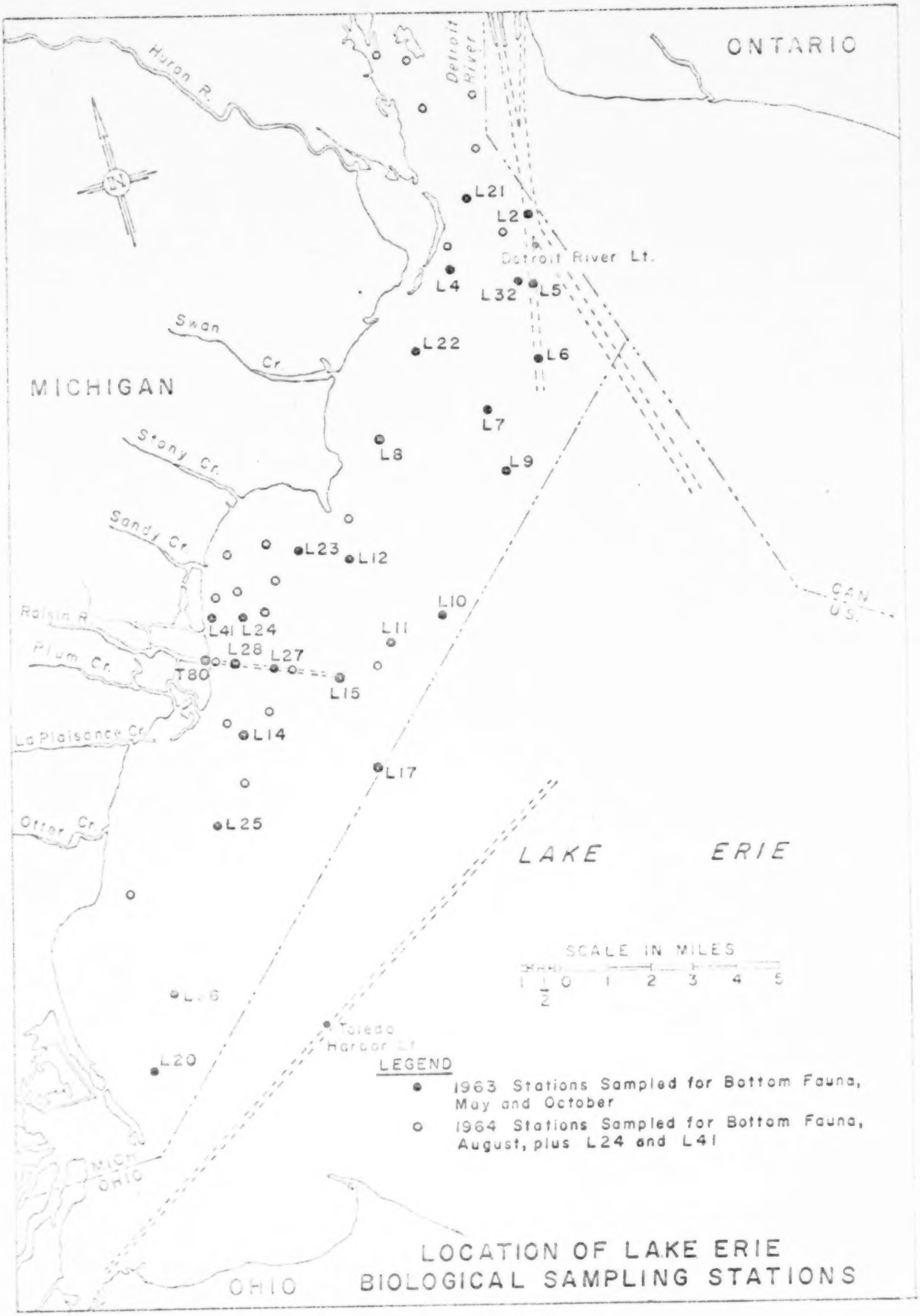
FIGURE 26



LOCATION OF LAKE ERIE BIOLOGICAL SAMPLING STATIONS